MANTHAN NEET 2025

SANKALP NEET VEDANTU

cell unit of life

lecture-01

Botany

TARUN SIR

Syllabus

Cell unit of life – 2-3 – Easy

Cell cycle and cell division – 4 Q

Living world – 1-2 Q

Biological classification 3-4

Plant kingdom 2-3 | 3-4

Morphology of flowering plants – 5 Q

Anatomy of flwoering plants – 2 Q

Photosynthesis → 2-3

Respiration in plants → 2-3

Plant growth and development → 4-5

Sexual reproduction in flowering plant 2-3

Principle of inheriatance
Molecular basis of inheritance
– 10-12 Q

Micorbes in human welfare – 2 Q

Organsim and population – 2 Q
Ecosystem – 2 Q
Biodiversity and conservation – 5 Q
} 9-10 Q

Topic

- ✓ Basic introduction of cell
- prokaryotic cell
- Eukaryotic cell
- cell membrane →
- Cell wall →
- Endomembrane system →
- ER →
- Golgi bodies →
- lysosome →
- vacuole →
- Mitochondria →
- plastids →
- Ribosomes →
- Cytoskeletal Elements →
- Nucleus →
- Microbodies →
- Satellite →
- Cell theory

Today's Goal

Prokaryotic cell

Prokaryotic cell

Examples:- E.coli, lactobaccilus, Nostoc, Anabena, Mycoplasma (PPLO)

Some Basic points – (a) Present in Kingdom Monera

(b) Smaller than Eukaryotic cell

(c) Not well defined Nucleus

(d) Divide Faster than Eukaryotic cell

(e) Different shape → ○ - Coccus - (spherical) ⬭ Rod shape - Baccilus

→ Vibrio (comma shape)

Spirillium (Spiral)

Shape prokaryotic cell

(1) ○ - Coccus (Singular)

○○ - Cocci (Plural)

(2) Rod shape →

Baccilus

(Many - Bacilli)

(c) Comma shape

- Vibrium (one)

Vibrio (plural many)

(d)

Spiral shape

Spirillium - one

Spirillia - many

note - Coccus not have Flagella

Size → normal - (2-5 Mm)

Mycoplasma - Smallest - 0.1 or 0.3 Mm

8.4 Prokaryotic Cells

The prokaryotic cells are represented by bacteria, blue-green algae, mycoplasma and PPLO (Pleuro Pneumonia Like Organisms). They are generally smaller and multiply more rapidly than the eukaryotic cells (Figure 8.2). They may vary greatly in shape and size. The four basic shapes of bacteria are bacillus (rod like), coccus (spherical), vibrio (comma shaped) and spirillum (spiral).

The organisation of the prokaryotic cell is fundamentally similar even though prokaryotes exhibit a wide variety of shapes and functions. All

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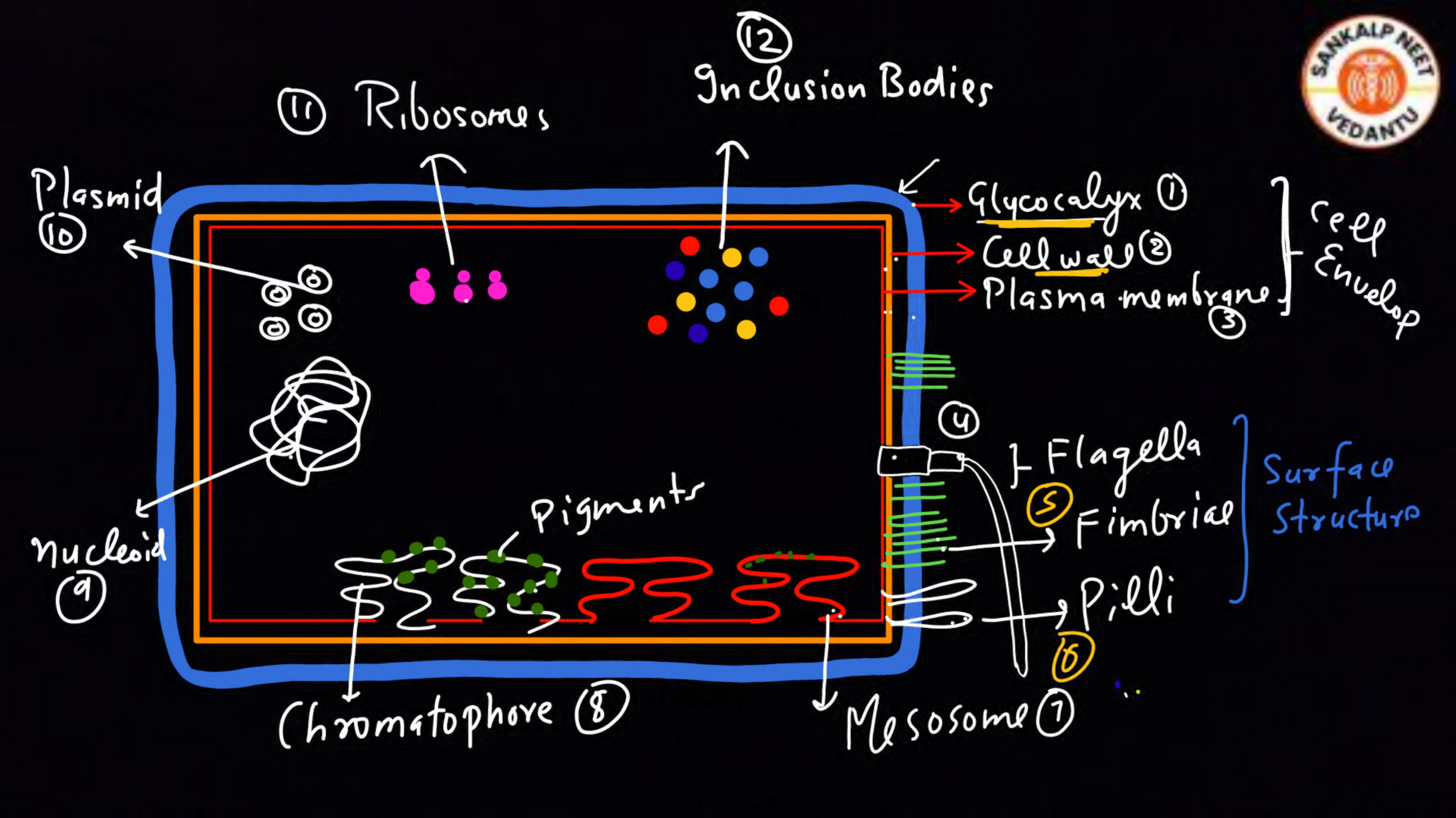

12 Inclusion Bodies
11 Ribosomes
Plasmid 10
Glycocalyx 1
Cell wall 2
Plasma membrane 3
Cell Envelop
4
Flagella 5
Fimbriae
Pilli 6
Surface Structure
Pigments
Nucleoid 9
Chromatophore 8
Mesosome 7

cell Envelop

Glycocalyx – Outermost layer – made of Carbohydrate –

Two type – of Glycocalyx

Slime layer

– loose and slimy

→ sticky

Capsule

– thick and tough

– Protection From host immune system

(1928)

Experiment Griffith

Streptococcus

- R – Rough – R (non-virulent)
- S – Smooth – S Strain

Capsule ↓ Protect Bacteria From host Immune System

Cell wall

Chemically it is → Peptidoglycan (Pg-17)

(NCERT- Non cellulosic carbohydrate + Amino Acids)

note- All Bacteria have cell wall (Except - Mycoplasma)

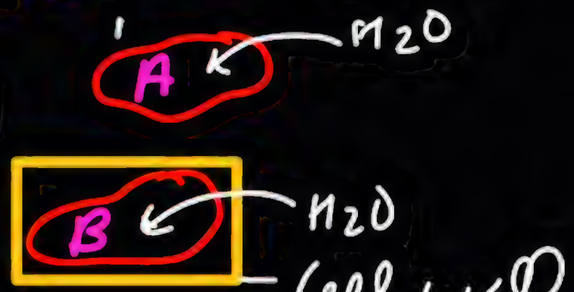
Role of cell wall

(a) Provide shape ✓

(b) Cell wall Rigid structure ✓

(c) Prevent From Bursting & Collapsing

(B cell not Burst → as cell wall is present)



(d) Prevent From Mechanical damage

Cytoplasm – Hypertonic (more) (salt)
(Solute)

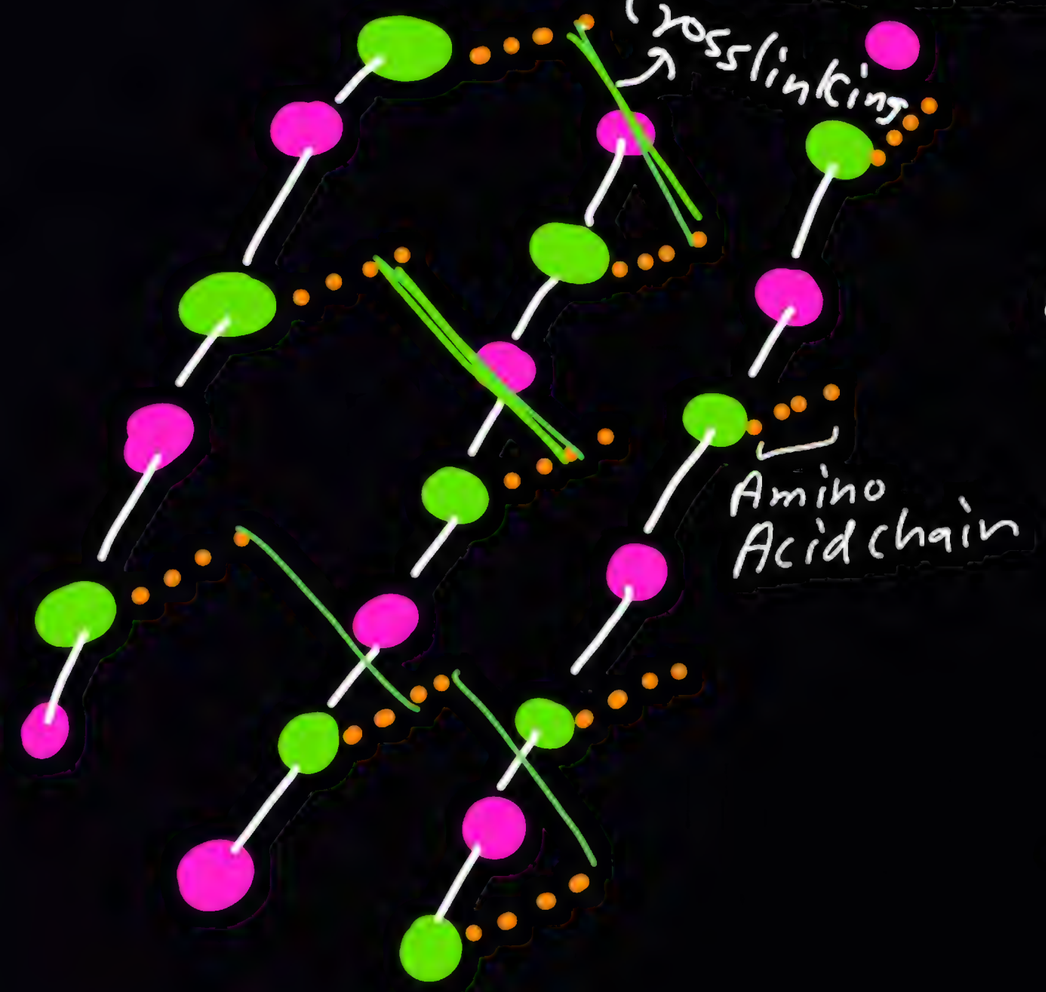
Pure water (Hypo tonic)
(No Solute)

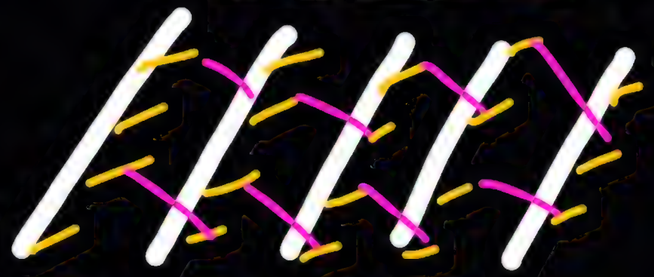
Water move – Hypotonic to Hypertonic

If Any cell kept in Hypotonic solution
↓
Water Enter
↓
Cell Burst

structure ofcellwall

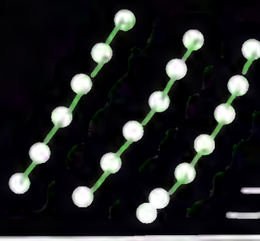
Glucose → NAG (N-Acetyl Glucosamine → NAM (N-Acetyl muraminic Acid)





NAG Form Due to Chemical modification of Glucose

NAM Form Due to Chemical modification of NAG



Chain of Glucose = Cellulose

- Chain of NAG ✓
- Chitin

Chain of NAG + NAM + Amino Acid = Peptido glycan

* Plants → Cellulose cell wall – chain of β-D Glucose

* Fungi – chitin cell wall - chain of NAG

* Bacteria cell wall → chain of NAG + NAM
(Some Amino Acid help in cross linking

[Cellulose / chitin] – Homo polymer

Peptidoglycan – Heteropolymer

note – Penicillin Antibiotic Prevent cross linking of Bacterial cell wall

Lysozymes – Digest Bacterial Cell Wall

Gram staining

(Staining – to Give colour → So that it is visible

Christian Gram → Develop method to stain Bacteria

On the Basis of thickness of Cell Envelop → two type of Bacteria

(a) Gram tve → Uptake stain / Retain stain — Ex – lactobacillus, Clostridium — other Featur (Mesosomes present)

(b) Gram –ve → Loose Stain / not uptake stain / Ex – E. coli, Mycoplasma, cyanobacteria (Pilli and Porins present)

DOPA -01

Q1 Which is Surface structure
(a) Cell wall (b) Flagella (c) cell Membrane (d) Glycocalyx

Q2 Glycocalyx and cell Membrane have similarity
(a) Both Lipid (b) Part of Cell Envelop (c) Part of Surface structure (d) all

Q3 Wrongly matched
(a) Pilli – Bacteria (b) Well defined nucleus – E. coli
(c) Nucleoid – Lactobacillus (d) Slime layer – Loose

Q4 Cell wall of Bacteria
(a) Chain of Glucose (b) Chain of NAG (c) Non cellulosis Carbohydrate + Amino Acid (d) all

Q5 Cell Envelop not have part
(a) Flagella (b) Pilli (c) Nucleoid (d) all

Q6 Glycocalyx not have Feature

(a) Slime layer (b) Capsule (c) Carbohydrate (d) Peptidoglycan

Q7 S-I Nostoc is prokaryotic cell
S-II E. coli is Eukaryotic cell

Q8 S-I Streptococcus have two Flagella
S-II lactobacillus not have nucleus

Q9 S-I Mesosomes are structure derive From cell wall
S-II nucleoid present in yeast

Q10 - S-I PPLO is larger than Amoeba
S-II Bacteria Different in Shape & Function

(a) only S-I (b) Only S-II (c) Both S-I & S-II (d) Both wrong

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S-II Bacteria Different in Shape & Function ✓ b

(a) only S-I (b) Only S-II (c) Both S-I & S-II (d) Both wrong

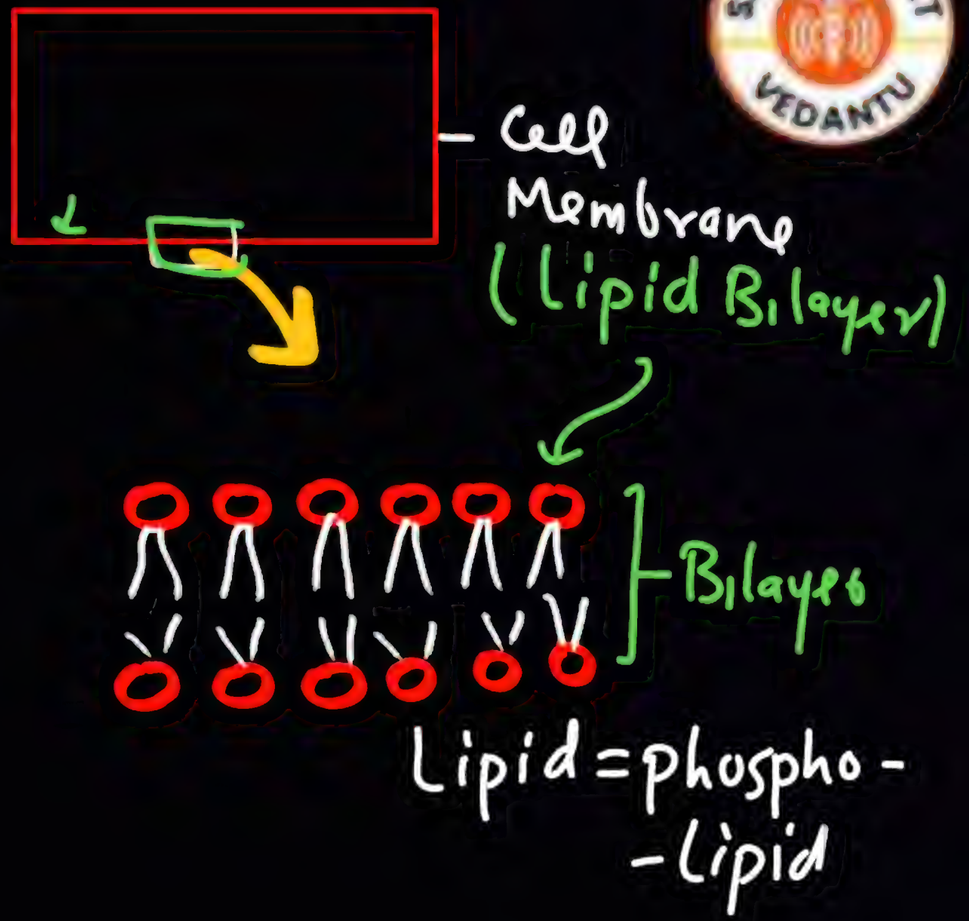
Cell membrane

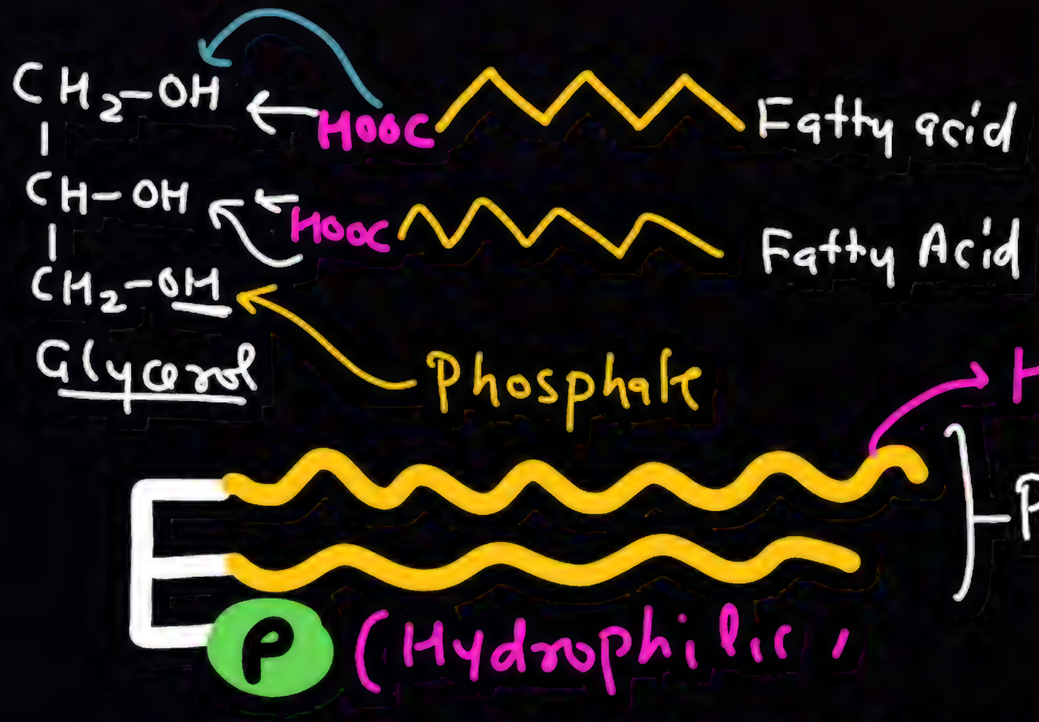
- Structure Similar to Eukaryotic membrane

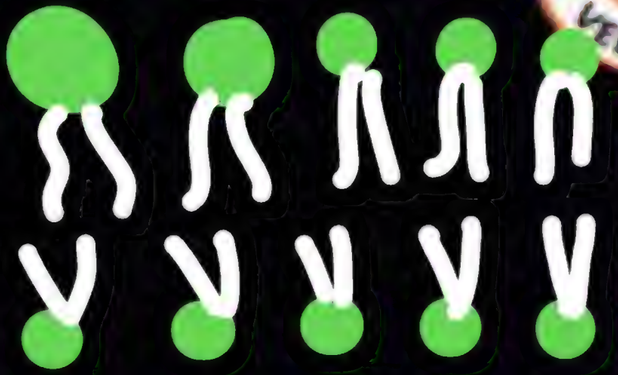
(Both prokaryotic & Eukaryotic membrane made up of lipid Bilayer)

Q Similarity B/w E.coli & yeast

(a) Cell wall (b) Nucleus (c) Cell membrane (d) all







Q true For Membrane made up of Fat

(b) Lipid Bilayer

(c) Phospholipid Bilayer

(d) Made up of protein only

Surface structure – ① Flagella ② Fimbriae ③ Pilli

Flagella – Flagella present in Single cell

help in movement | motility

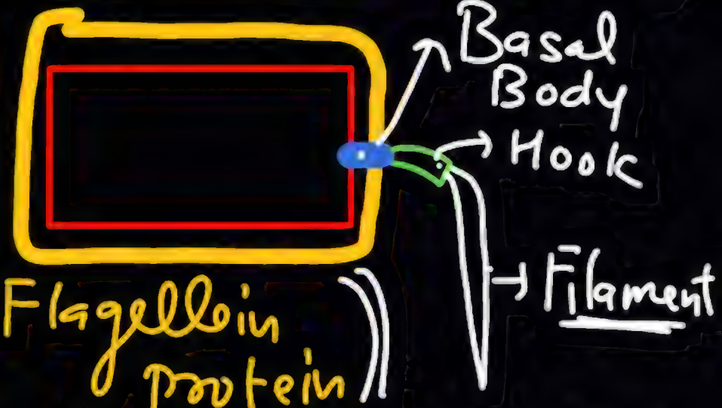
Prokaryotic – Flagella can present ✓

Eukaryotic → can present ✓ Flagella

(Structure Different)

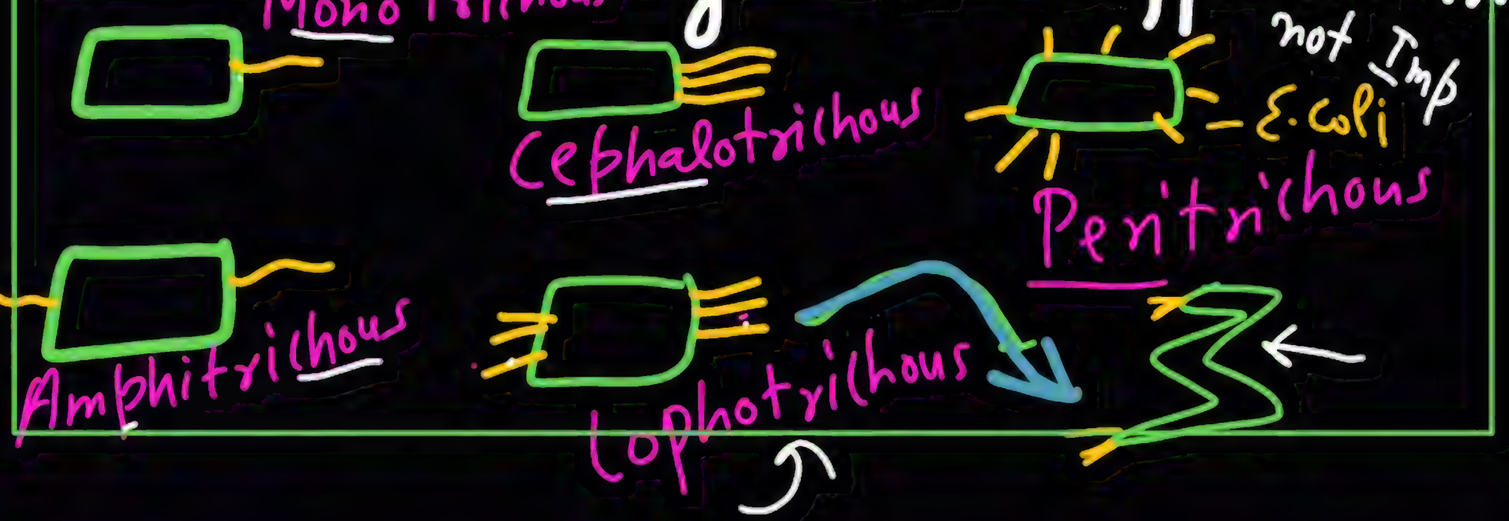
Prokaryotic Flagella – Not present in all → Bacteria

Three part ✓ (a) Basal Body ✓ (b) Hook ✓ (c) Filament



(All three Part of Flagella – made up of Flagellin protein)

No. and Arrangement – Different in Different Bacteria cell



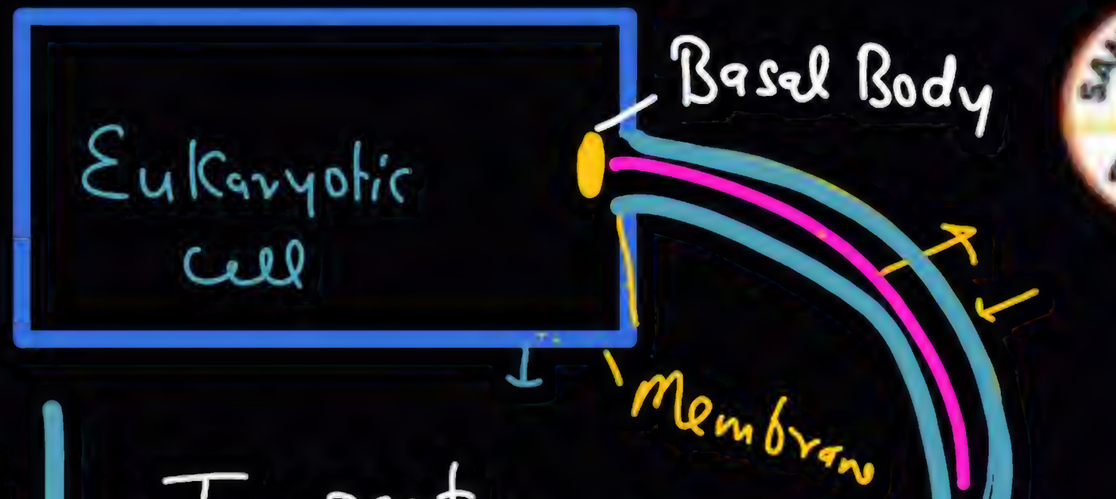
No Flagella (non-motile)

Ex- Cyanobacteria, Coccus, Mycoplasma

→ Three part - Basal Body, Hook
Filament

→ No membrane involve ✓

→ Made up of Flagellein protein]



Two part
(a) Basal Body
(b) Filament

→ Membrane involve
- made up of tubulin Protein]

→ Pilli

note - no Role in motility

made up of

Special protein (Pillin)

Tubular

✓ - Long and tubular shape

✓ - less in number

→ Special Role perform

Fimbriae

Bristle shape

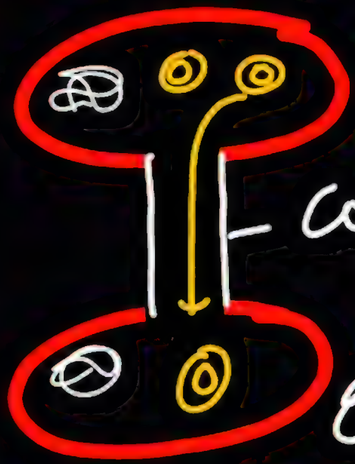
Role - Attachment on substratum (Rock, Host)

In Some Bacteria - Sexual Reproduction occur

Special type pilli → Sex pilli ✓

no plasmid (E.coli)

(E.coli) Fertility plasmid (F-plasmid)



E.coli

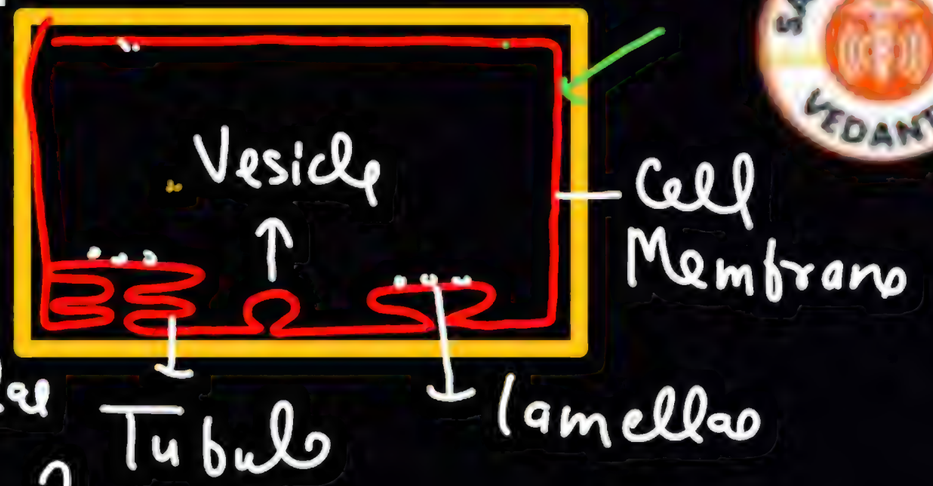
Conjugation tube Due to sex pilli

E.coli

Structure inside Bacteria cell

Mesosomes – Structures develop By Cell Membrane

They are – infolding / Extensions of Cell Membrane



Three shapes → (a) tubules (b) Vesicles (c) lamellae

[Mesosomes Form For – increase in Surface Area]

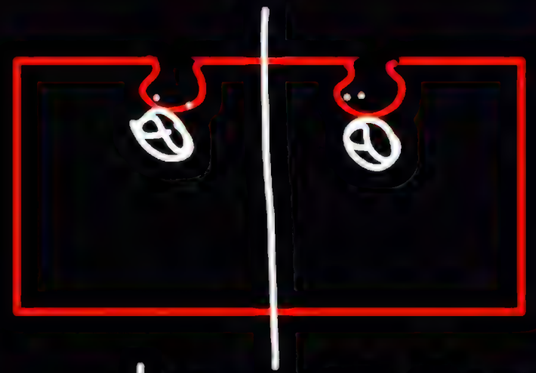
Functions – (a) Respiratory Enzyme attach on mesosome

(Q → Structure Analogus to mitochondria present in Bacteria
(a) Ribosome (b) Mesosome (c) Plasmid (d) Chromatophore

(b) Help in DNA Replication and Cell Division

nucleoid
(Attach to
mesosome)
(DNA)

DNA Replication
help By Mesosome



two mesosome Form
Cell Divide

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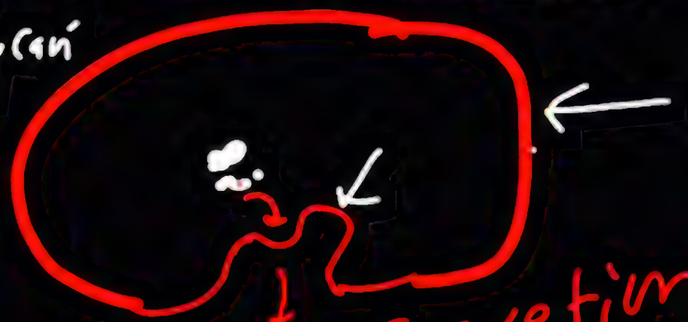
③ Cell wall Formation

cell Membrane

cell wall (Peptidoglycan

④ Mesosome help in
Secretion

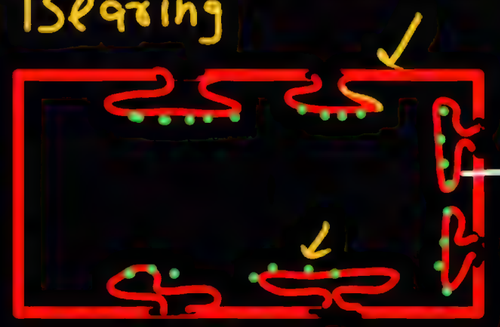


Secretion

Chromatophore → Some photosynthetic Bacteria → Cyanobacteria (Nostoc, Anabena)

Colour (Pigment)

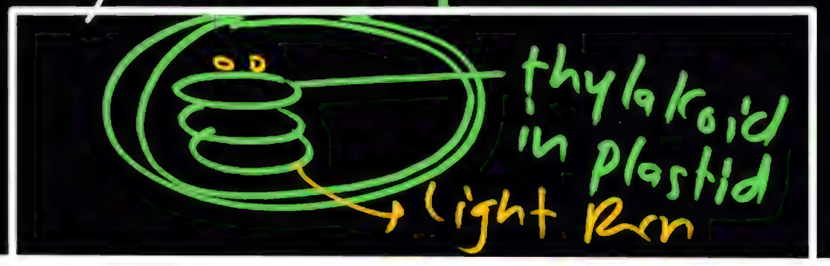
Bearing



Infolding | Extension of Plasma membrane (Pigments attach) — Mainly-Chla

Role → Photosynthesis → Light Rxn

(Chromatophore is Analogus to → thylakoids



Chromatophore

made up of — Extension of Plasma membrane

Role → Photosynthesis

→ Pigment present

Mesosome

- Extension of Plasma membrane

Role – Respiration + other role

→ Pigment Absent

DNA in Bacteria ⟶ (a) Nucleoid (b) Plasmid

Bacteria DNA ⟶ (a) Double strand
(b) Circular DNA

(c) Without Any membrane ⟶ Present in Cytoplasm
(naked DNA)

(d) all Essential gene is present on Nucleoid | Genomic DNA

Nucleoid

note- In Real Chromosome not present in Bacteria
But we can consider, nucleoid is single chromosome

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- Cell theory

cell theory

Cell membrane

- Structure Similar to Eukaryotic membrane

(Both prokaryotic & Eukaryotic membrane made up of lipid Bilayer)

Q Similarity B/w E.coli & yeast

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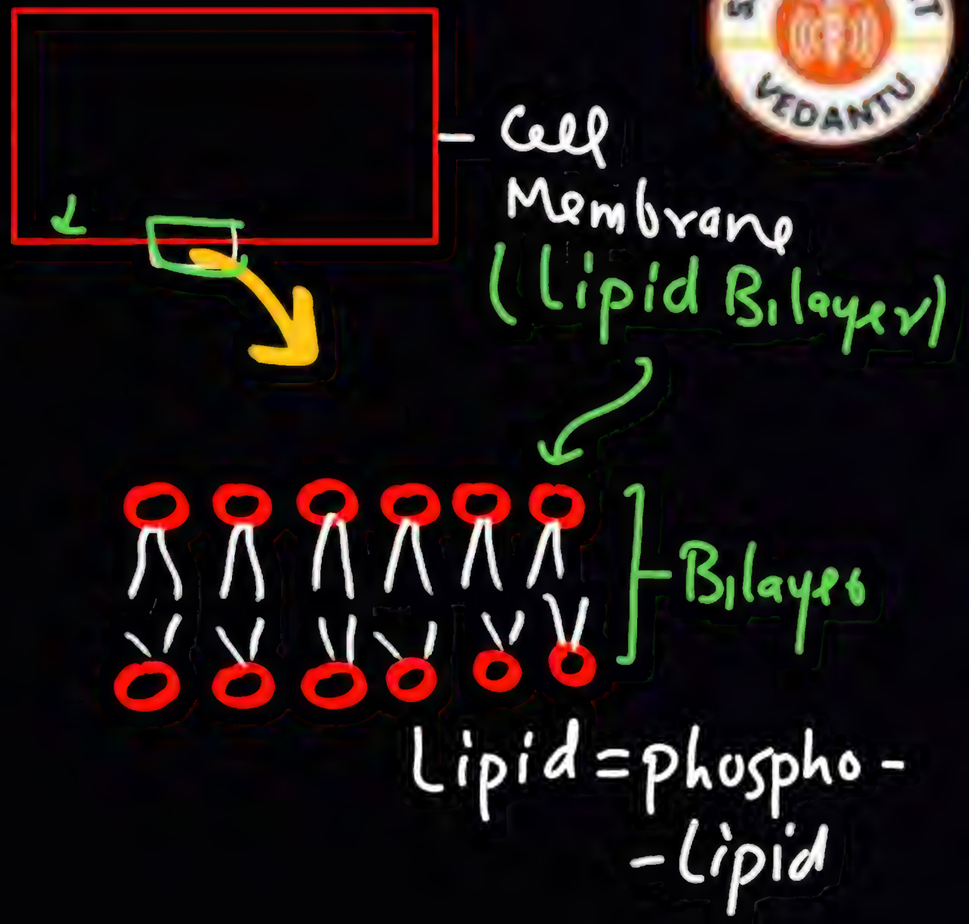
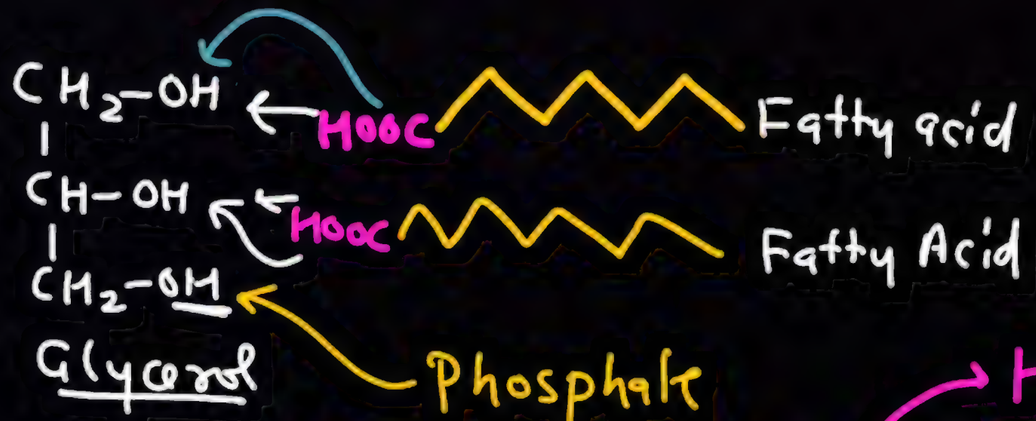
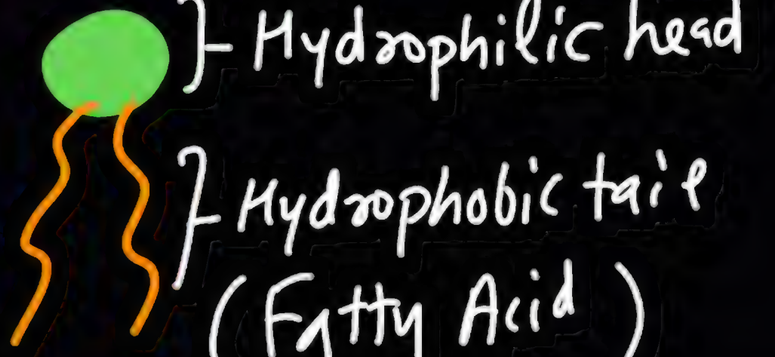
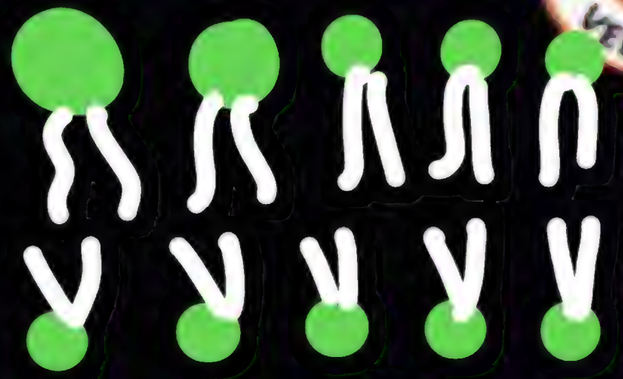


cell theory







Q true For Membrane
(a) made up of Fat
(b) Lipid Bilayer
(c) Phospholipid Bilayer
(d) made up of protein only

cell theory

Surface structure – ① Flagella ② Fimbriae ③ Pilli

Flagella

Flagella present in Single cell → motility → help in movement

Prokaryotic – Flagella can present ✓

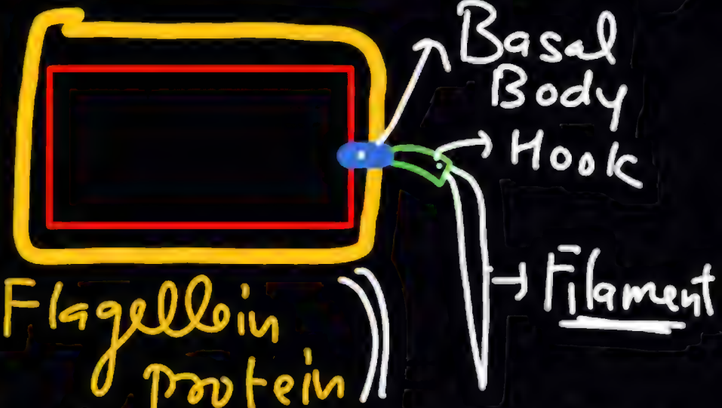
Eukaryotic → can present Flagella ✓

(Structure Different)

Prokaryotic Flagella – Not present in all → Bacteria

Three part:
- (a) Basal Body ✓
- (b) Hook ✓
- (c) Filament ✓

(All three Part of Flagella – made up of Flagellin protein)



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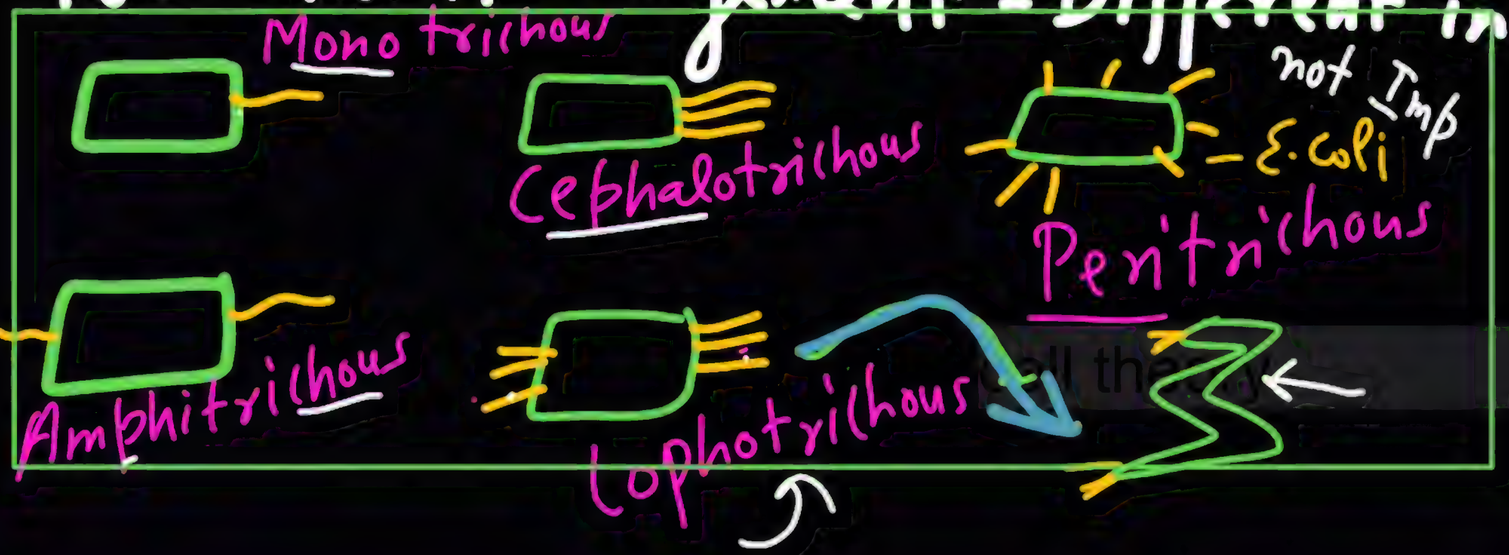
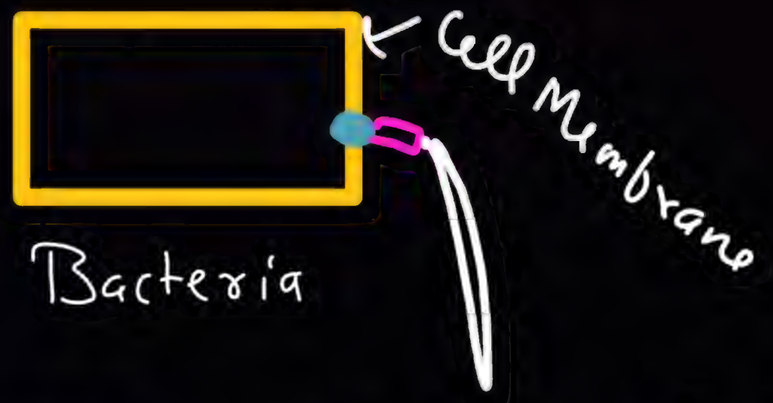


No Flagella (non-motile)

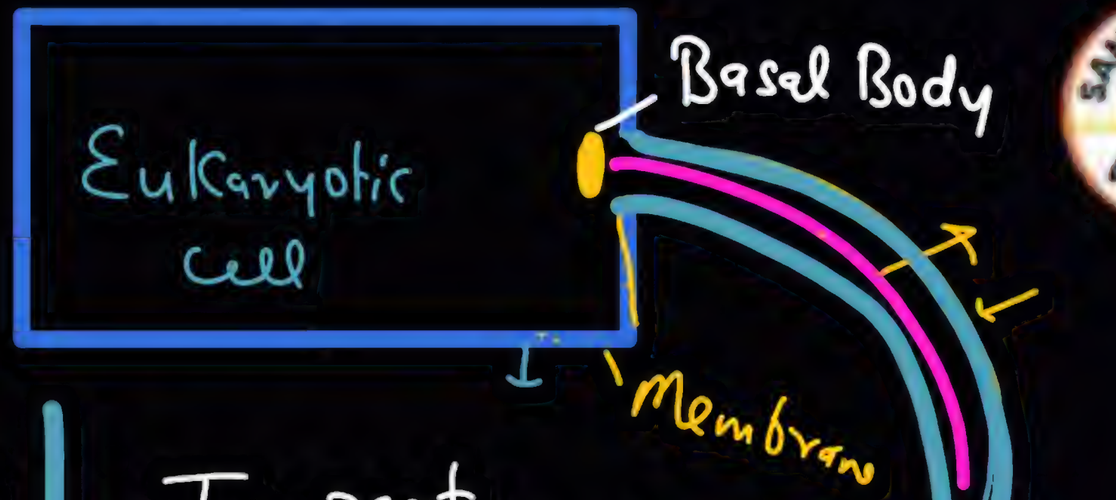
Ex- Cyanobacteria, Coccus, Mycoplasma



→ Three part - Basal Body, Hook
Filament

→ No membrane involve ✓

→ Made up of Flagellein protein]



Two part
(a) Basal Body
(b) Filament

→ Membrane involve
- made up of tubulin Protein]

cell theory

Pilli

note - no Role in motility

made up of

Special protein (Pillin)

Tubular

✓ - Long and tubular shape

✓ - less in number

→ Special Role perform

Fimbriae

Bristle shape

Role - Attachment on substratum (Rock, Host)

In Some Bacteria - Sexual Reproduction occur

Special type pilli → Sex pilli

no plasmid (E.coli)

(E.coli) Fertility plasmid (F-plasmid)

E.coli

Conjugation tube Due to sex pilli

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Structure inside Bacteria cell

Mesosomes – Structures develop By Cell Membrane

They are – infolding / Extensions of Cell Membrane

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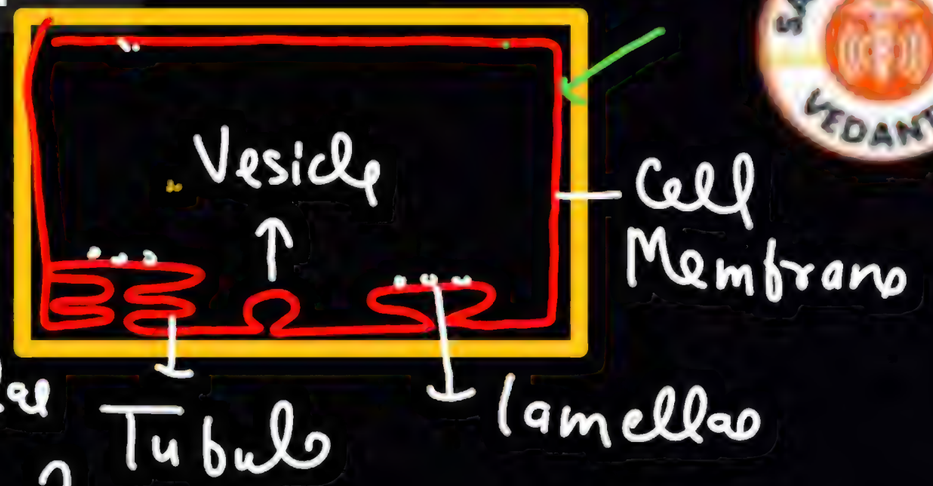
[Mesosomes Form For – increase in Surface Area]

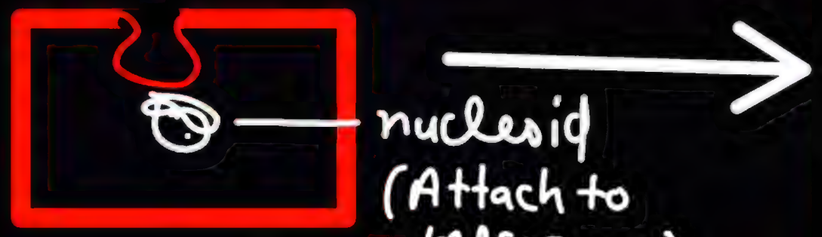


Functions – (a) Respiratory Enzyme attach on mesosome

(Q → Structure Analogus to mitochondria present in Bacteria
(a) Ribosome (b) Mesosome (c) Plasmid (d) Chromatophore

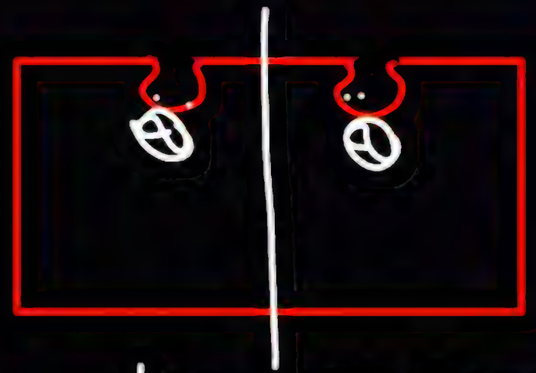
(b) Help in DNA Replication and Cell Division

cell theory



nucleoid
(Attach to
mesosome)
(DNA)

DNA Replication
help By Mesosome



two mesosome Form
Cell Divide

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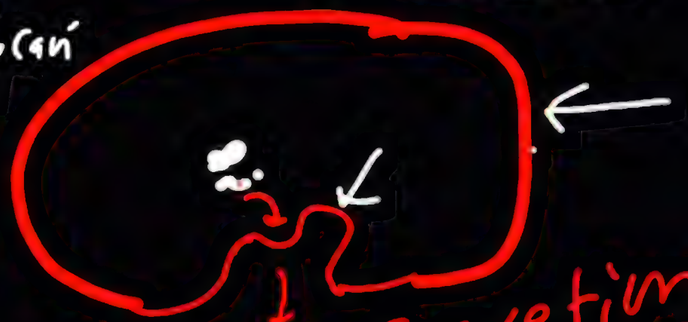
③ Cell wall Formation

cell Membrane

cell wall (Peptidoglycan

④ Mesosome help in
Secretion



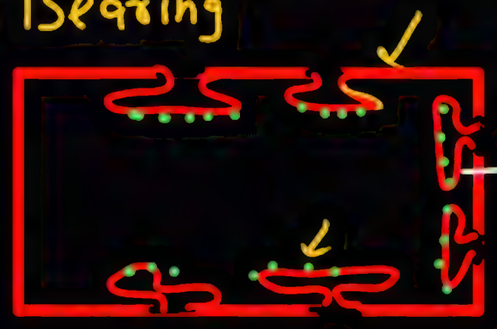
Secretion

cell theory

Chromatophore → Some photosynthetic Bacteria → Cyanobacteria (Nostoc, Anabena)

Colour (Pigment)

Bearing



→ Infolding | Extension of Plasma membrane (Pigments attach) → Mainly-Chla

Role → Photosynthesis → Light Rxn

(Chromatophore is Analogus to → thylakoids

Chromatophore

made up of — Extension of Plasma membrane

Role → Photosynthesis

→ Pigment present

Mesosome

- Extension of Plasma membrane

Role – Respiration + other role

→ Pigment Absent

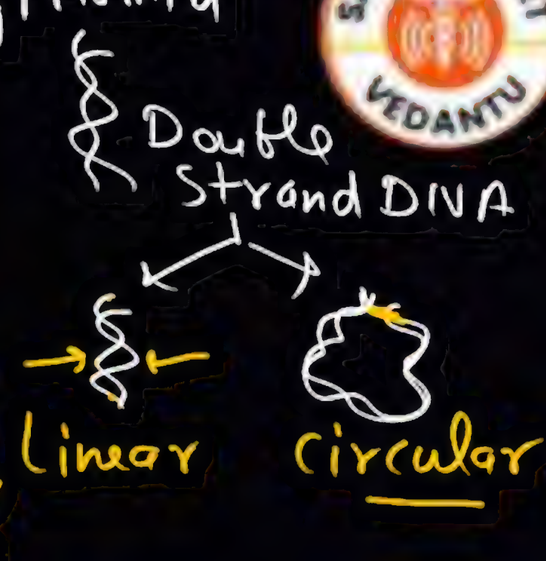
cell theory

DNA in Bacteria → (a) Nucleoid (b) Plasmid

Bacteria DNA → (a) Double strand ✓
(b) Circular DNA ✓

(c) Without Any membrane → Present in Cytoplasm
(naked DNA) ✓

(d) all Essential gene ✓ is present on Nucleoid | Genomic DNA



note- In Real Chromosome not present in Bacteria
But we can consider, nucleoid is single chromosome

note - Histones Absent

Botany- cell ✓

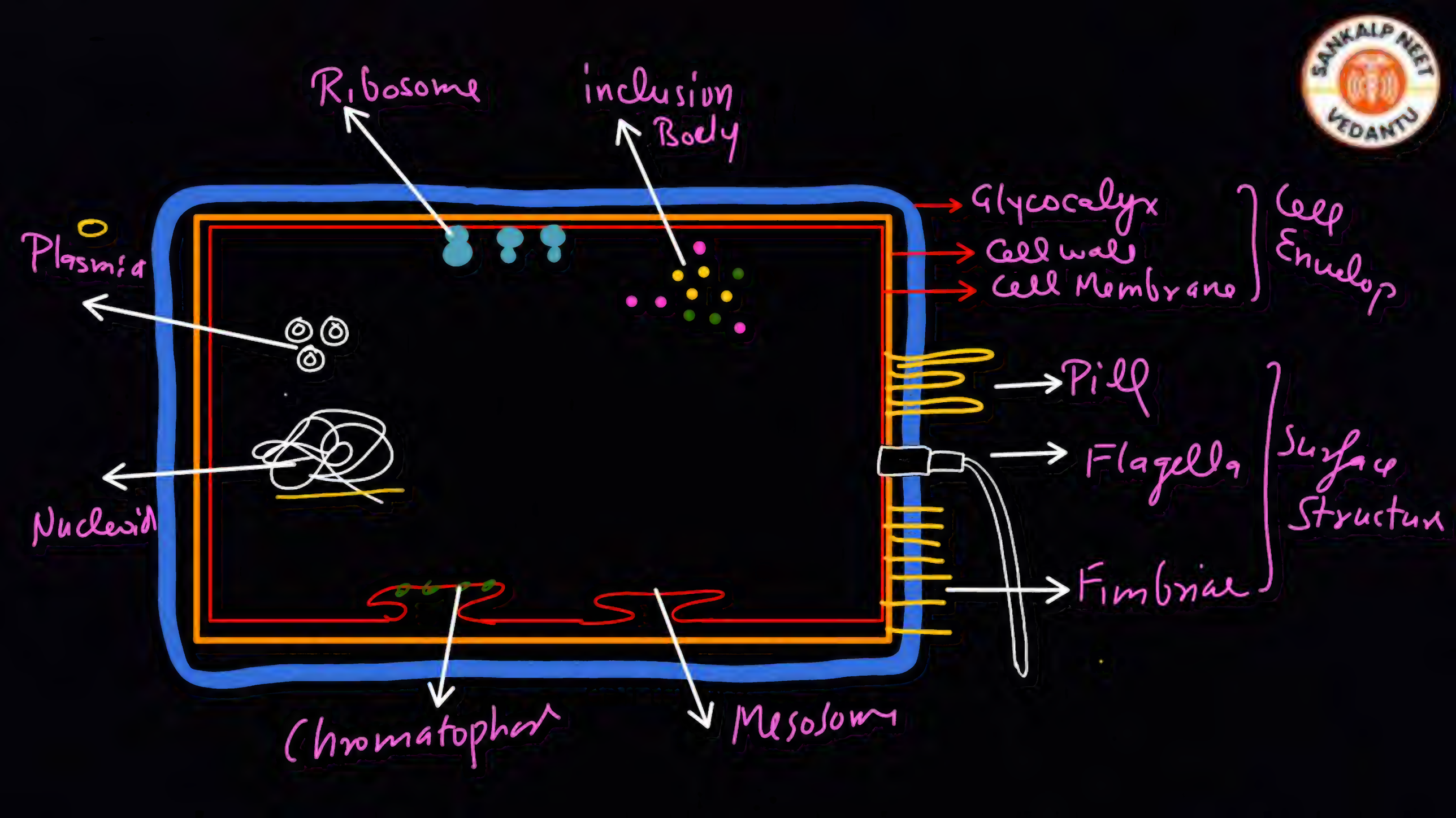
↓

- Theory + DOPA + DPP (PPF) (VS)

- Extra questions_ Prokaryotic - 40 Q
  Eukaryotic - 150 Q ✓

lec - 1
lec - 2 } Prokaryotic
lec - 3 →

Telegram + App


Ribosome
inclusion Body
Plasmid
Nucleoid
Chromatophore
Mesosome
Glycocalyx
Cell wall
Cell Membrane
Cell Envelop
Pili
Flagella
Fimbriae
Surface Structure

Plasmid

Feature → Other than main DNA (nucleoid)

(a) Extra chromosomal
(b) Double Stranded (c) Circular
(d) Self Replicating (have origin)

Nucleoid	Plasmid
Double strand	
Circular	
main DNA (All Essential gene)	X (Extra gene)
all cells (Bacterial cells)	X

§ → § §
cloning
(Make cop)

Q Why plasmid Act as cloning Vector

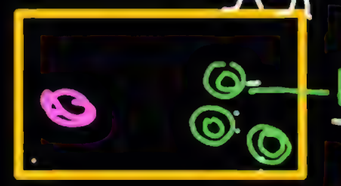
(a) double stranded
(b) Circular
(c) have origin
(d) Extra chromosomal

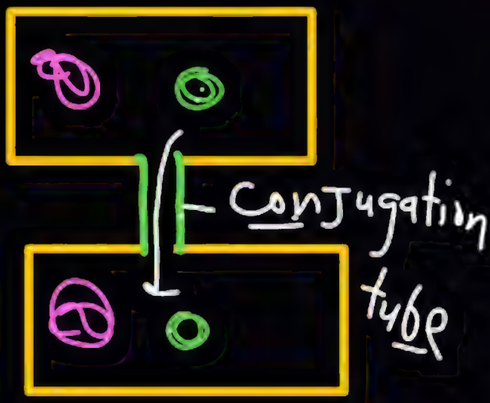
Role of Plasmid - Extra Phenotypic character

Type of Plasmid

F-Plasmid - Fertility plasmid help in Sexual Reproduction

Bacteria with Sex pilli produce conjugation tube
By which plasmid move into other cell





R plasmid - R-Resistance (It protect Bacteria From Antibiotic)

Antibiotic kill

no plasmid

tetracyclin

tetracylin (Antibiotic) Resistance

(Bacteria Survive)

Type of Plasmid

Ti plasmid

↓

Tumour inducing Plasmid

Agrobacterium tumifaciens ⟶ have Ti plasmid
(induce tumour in tobacco plant Root)

Q Which is not correct

(a) Plasmid carry Extra gene ✓

(b) Plasmid present in all Bacteria X

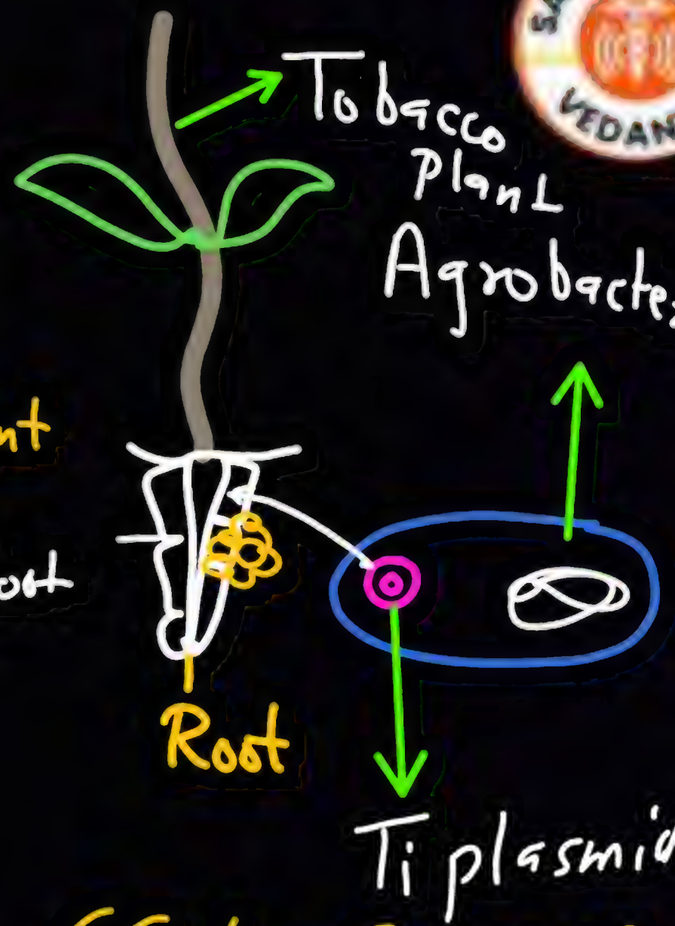
(c) Two plasmid Ti & F present in same bacteria X

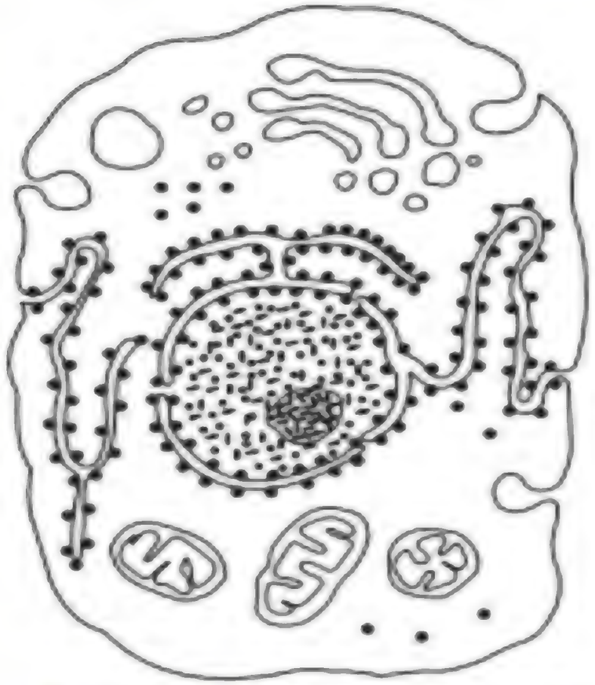
(I) a & b incorrect

(II) b & c incorrect ✓

(III) all incorrect

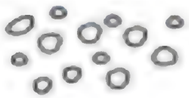
(IV) only b incorrect



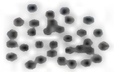


A typical eukaryotic cell
(10-20 μm)

Typical bacteria
(1-2 μm)



PPLO
(about 0.1 μm)



Viruses
(0.02-0.2 μm)

Figure 8.2 Diagram showing comparison of eukaryotic cell with other organisms

prokaryotes have a cell wall surrounding the cell membrane except in mycoplasma. The fluid matrix filling the cell is the cytoplasm. There is no well-defined nucleus. The genetic material is basically naked, not enveloped by a nuclear membrane. In addition to the genomic DNA (the single chromosome/circular DNA), many bacteria have small circular DNA outside the genomic DNA. These smaller DNA are called plasmids. The plasmid DNA confers certain unique phenotypic characters to such bacteria. One such character is resistance to antibiotics. In higher classes you will learn that this plasmid DNA is used to monitor bacterial transformation with foreign DNA. Nuclear membrane is found in eukaryotes. No organelles, like the ones in eukaryotes, are found in prokaryotic cells except for ribosomes. Prokaryotes have something unique in the form of inclusions. A specialised differentiated form of cell membrane called mesosome is the characteristic of prokaryotes. They are essentially infoldings of cell membrane.

Ribosomes

(ribosomal RNA)

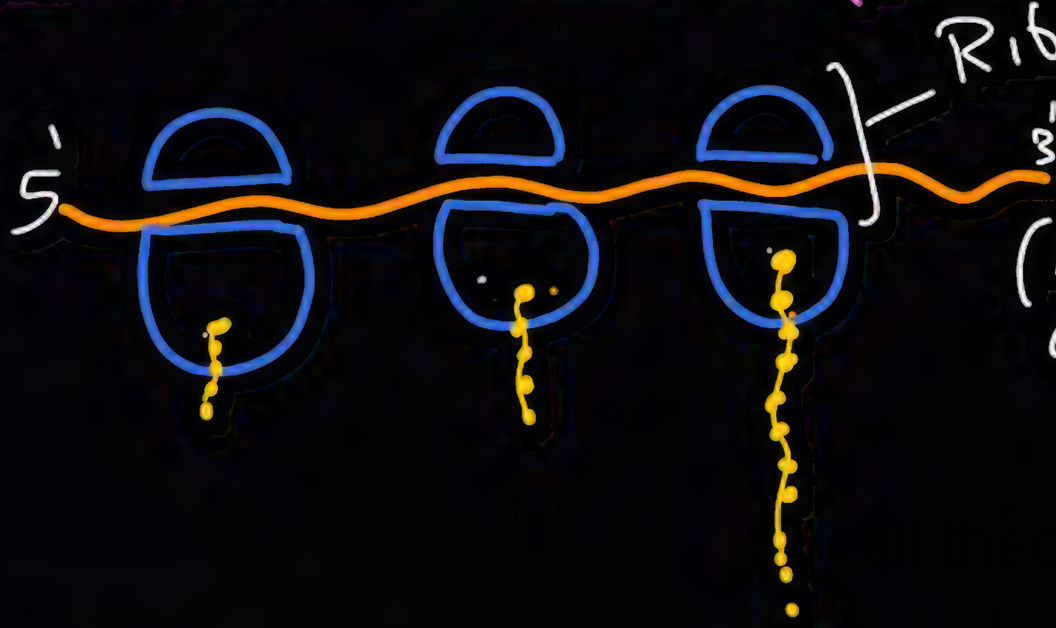
Chemically – made up of RNA (rRNA) + protein [Ribonucleo protein]

size – 15-20 nm

Location – Ribosome attach with Membrane + Free in Cytoplasm

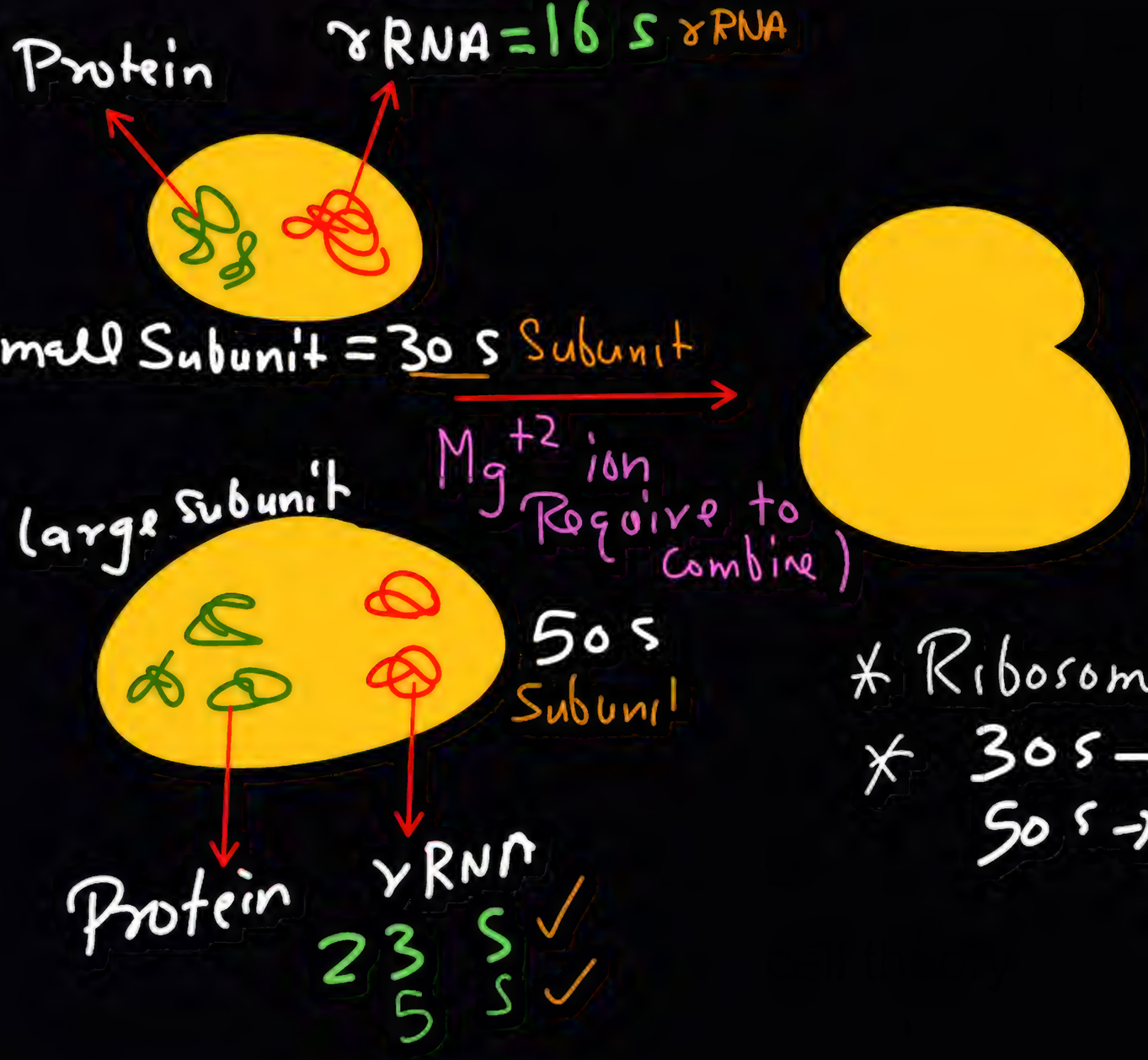
– without Membrane organelle

Role – involve in translation (protein Synthesis)



Polysomes / Polyribosomes

On Single mRNA many Ribosome attach to make protein



Complete Ribosome = 70 S (Prokaryotes Cytoplasm)

* Ribosome is made up of two subunit
* 30 S → small
  50 S → large
) — Complete Ribosome

8.4.2 Ribosomes and Inclusion Bodies

In prokaryotes, ribosomes are associated with the plasma membrane of the cell. They are about 15 nm by 20 nm in size and are made of two subunits - 50S and 30S units which when present together form 70S prokaryotic ribosomes. Ribosomes are the site of protein synthesis. Several ribosomes may attach to a single mRNA and form a chain called **polyribosomes** or **polysome**. The ribosomes of a polysome translate the mRNA into proteins.

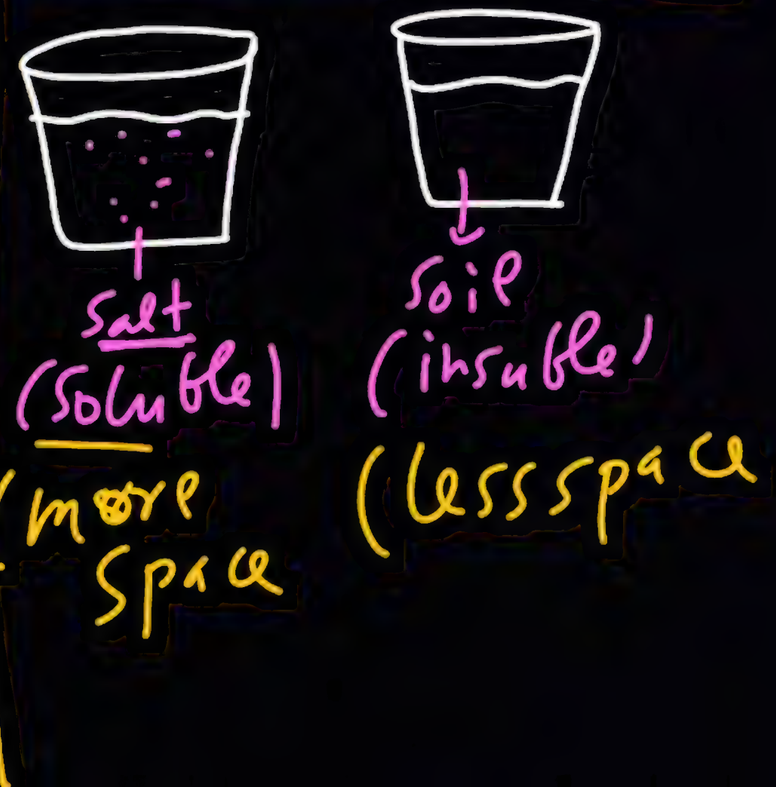
Inclusion Body

- Eukaryotes – Storage → inside Membrane structure
- Prokaryotes → storage (Reserve material) not Store inside membrane

(Membrane Bound organelle Absent)

Inclusion Bodies – structure for storage / Reserve Mater's

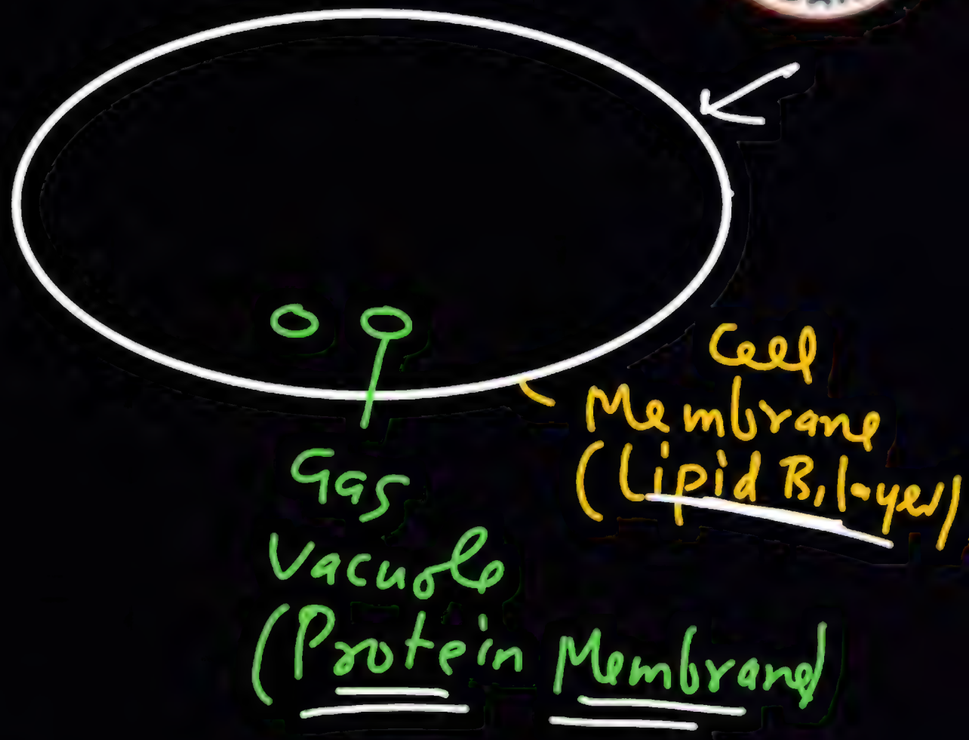
- Present in cytoplasm ✓
- Without Membrane ✓
- Granular ✓
- Stored in insoluble form ✓



Type of inclusion Body

1. Phosphorus granule — Store Phosphorus
2. Sulfur granule → Store Sulfur
3. Glycogen granule → Glycogen Store
4. Cyanophycean Granule – Amino Acid store
   (Present in cyanobacteria)
5. Gas vacuole — only in prokaryotes
   Ex- Cyanobacteria
   - Green Sulfur Bacteria
   - Purple sulfur Bacteria

→ Photosynthetic Bacteria ✓



Inclusion bodies Reserve material in prokaryotic cells are stored in the cytoplasm in the form of inclusion bodies. These are not bound by any membrane system and lie free in the cytoplasm, e.g., phosphate granules, cyanophycean granules and glycogen granules. Gas vacuoles are found in blue green and purple and green photosynthetic bacteria.

8.4 Prokaryotic Cells

The prokaryotic cells are represented by bacteria, blue-green algae, mycoplasma and PPLO (Pleuro Pneumonia Like Organisms). They are generally smaller and multiply more rapidly than the eukaryotic cells (Figure 8.2). They may vary greatly in shape and size. The four basic shapes of bacteria are bacillus (rod like), coccus (spherical), vibrio (comma shaped) and spirillum (spiral).

The organisation of the prokaryotic cell is fundamentally similar even though prokaryotes exhibit a wide variety of shapes and functions. All

8.4.1 Cell Envelope and its Modifications

Most prokaryotic cells, particularly the bacterial cells, have a chemically complex cell envelope. The cell envelope consists of a tightly bound three layered structure i.e., the outermost glycocalyx followed by the cell wall and then the plasma membrane. Although each layer of the envelope performs distinct function, they act together as a single protective unit. Bacteria can be classified into two groups on the basis of the differences in the cell envelopes and the manner in which they respond to the staining procedure developed by Gram viz., those that take up the gram stain are **Gram positive** and the others that do not are called **Gram negative** bacteria.

Glycocalyx differs in composition and thickness among different bacteria. It could be a loose sheath called the **slime layer** in some, while in others it may be thick and tough, called the **capsule**. The **cell wall** determines the shape of the cell and provides a strong structural support to prevent the bacterium from bursting or collapsing.

The plasma membrane is selectively permeable in nature and interacts with the outside world. This membrane is similar structurally to that of the eukaryotes.

A special membranous structure is the **mesosome** which is formed by the extensions of plasma membrane into the cell. These extensions are in the **form of vesicles, tubules and lamellae**. They help in cell wall

formation, DNA replication and distribution to daughter cells. They also help in respiration, secretion processes, to increase the surface area of the plasma membrane and enzymatic content. In some prokaryotes like cyanobacteria, there are other membranous extensions into the cytoplasm called chromatophores which contain pigments.

Bacterial cells may be motile or non-motile. If motile, they have thin filamentous extensions from their cell wall called flagella. Bacteria show a range in the number and arrangement of flagella. Bacterial flagellum is composed of three parts – **filament**, **hook** and **basal body**. The filament is the longest portion and extends from the cell surface to the outside.

Besides flagella, Pili and Fimbriae are also surface structures of the bacteria but do not play a role in motility. The **pili** are elongated tubular structures made of a special protein. The **fimbriae** are small bristle like fibres sprouting out of the cell. In some bacteria, they are known to help attach the bacteria to rocks in streams and also to the host tissues.

MANTHAN NEET 2025

SANKALP NEET VEDANTU

cell unit of life

lecture - 04

Botany

TARUN SIR

Topic

Basic introduction of cell

prokaryotic cell

Eukaryotic cell

cell membrane

Cell wall

Endomembrane system

ER

Golgi bodies

lysosome

vacuole

Mitochondria

plastids

Ribosomes

Cytoskeletal Elements

Nucleus

Microbodies

Satellite

cell theory

Today's Goal

- Eukaryotic cell - Basics
→ Cell Membrane

cell theory

Five kingdom Classification

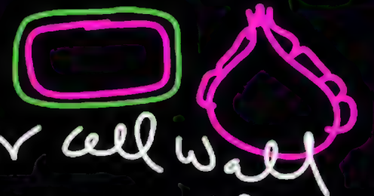
- Monera ① (Prokaryotic) (Unicellular)
- Eukaryotic
  - ② Protista (Unicellular)
  - ③ Fungi
  - ④ Plantae
  - ⑤ Animalia

Fungi, Plantae, Animalia — Multicellular

Eukaryotic cell

General features – ① It involve – Protista, Fungi, Plantae & Animalia
(Unicellular) (Multicellular)

② Eukaryotic cell → Examples → (a) Onion peel cell –



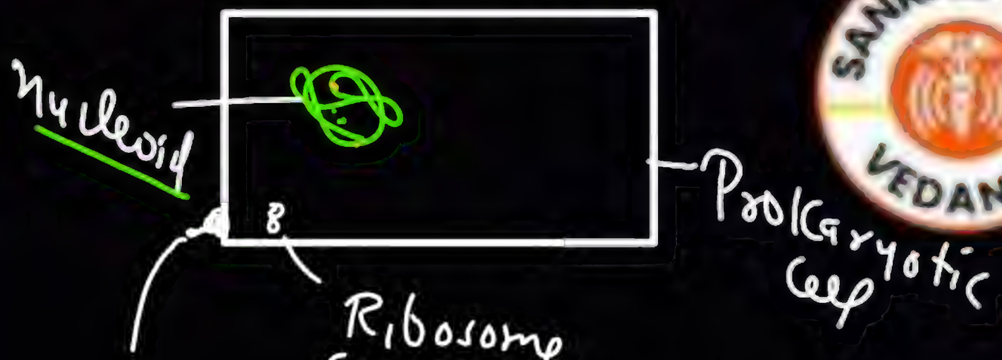
(Plant cell → outer cell wall
inner cell membrane]

(b) Cheek cell → outermost
(Animal cell cell membrane

③ Show Compartmentalization / Membrane Bound organelle
(Bacteria lack compartmentalization

④ Well defined nucleus present (and at the time of cell Division
Chromosome Form)

⑤ Proper locomotory structure & Support structure of Protein
(Cilia & Flagella)



→ Compartmentalization present in (P)

(a) E. coli (P) (b) Anabena (P) (c) Yeast (E) (d) PPLO

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(6) Eukaryotes cell → Size →

Prokaryotes size = 3–5 μm

Mycoplasma/PPLO (smallest → 0.1 μm / 0.3 μm)

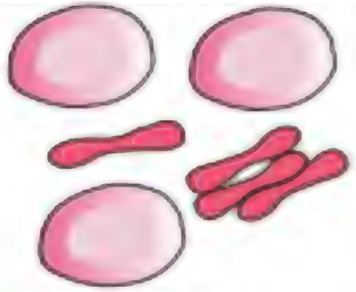
Eukaryotes = 10–20 μm – average size

RBC = 7 μm, largest cell = Ostrich Egg

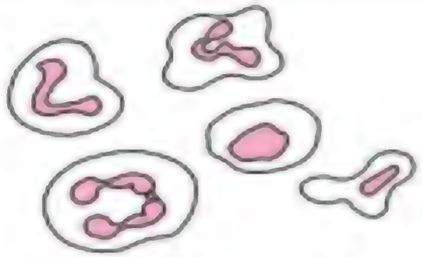
(7) Different shapes present.

(8) Eukaryotes → Organelles → with Membrane → Single.
→ Double Membrane
→ without Membrane

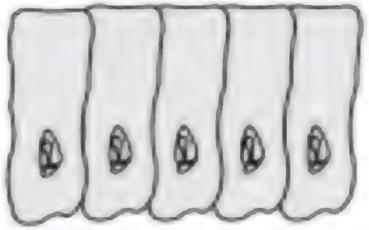
RBC



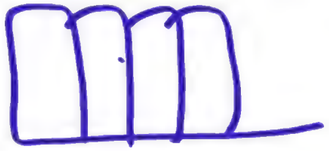
Red blood cells
(round and biconcave)

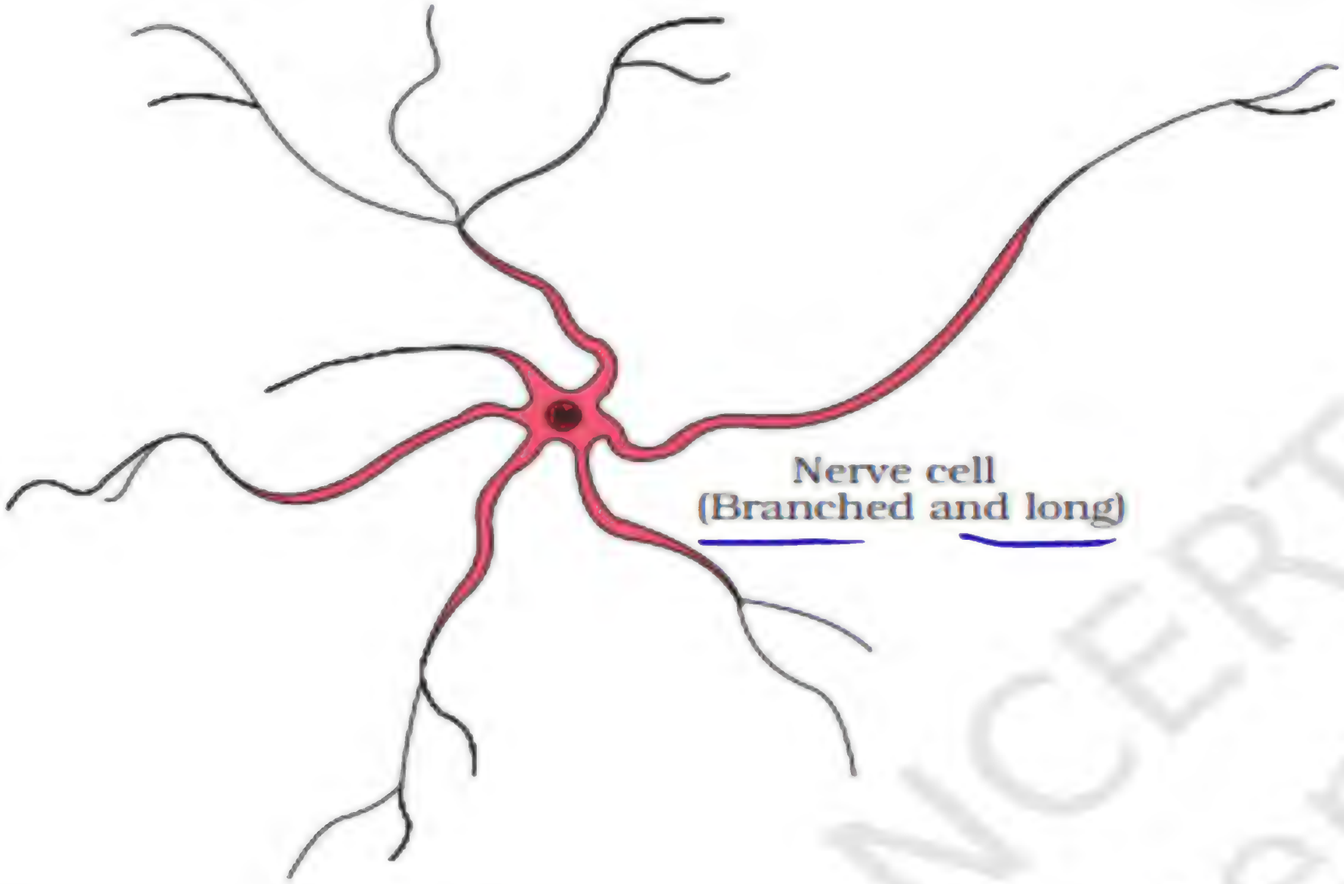


White blood cells
(amoeboid)



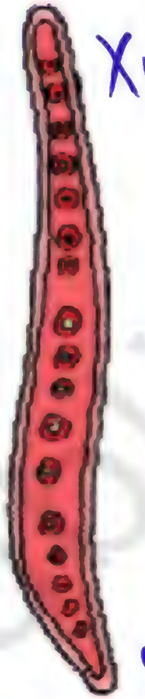
Columnar epithelial cells
(long and narrow)



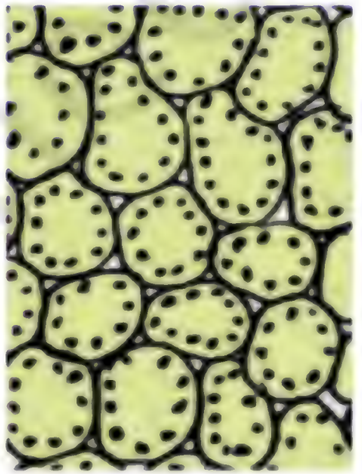


Nerve cell
(Branched and long)

Xylem



A tracheid
(elongated)



Mesophyll cells
(round and oval)

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Shape of eukaryotic cell

Cell	Shape
RBC	Round & Biconcave
WBC	Amoeboid (No Fix Shape)
Columnar epithelium	Narrow & long
Nerve cell	long & Branched
Tracheids	Elongated
Mesophyll cell	Round & oval

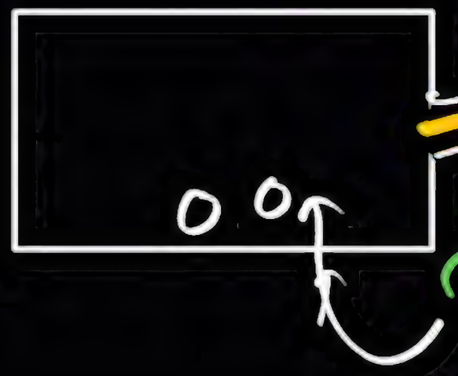
Organelles

Double membrane

- Plastids (chloroplast)
- Mitochondria
- Nucleus

Single membrane

- ER (Endoplasmic Reticulum)
- Golgi bodies
- Lysosomes
- Vacuoles
- Vesicles, Flagella Cilia (Flagella)



Peroxisomes (Microbodies)

Without membrane

- Ribosome
- Nucleolus (Inside nucleus)
- Centriole (Animal cell only)

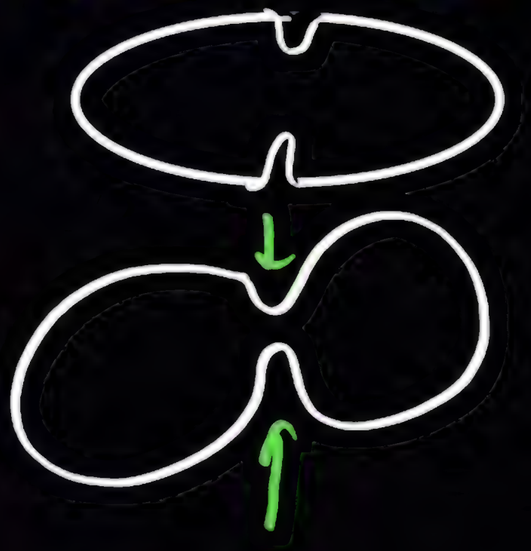
Animal cell

→ no cell wall

→ large central vacuole Absent

→ Centriole present

→ Plastids Absent



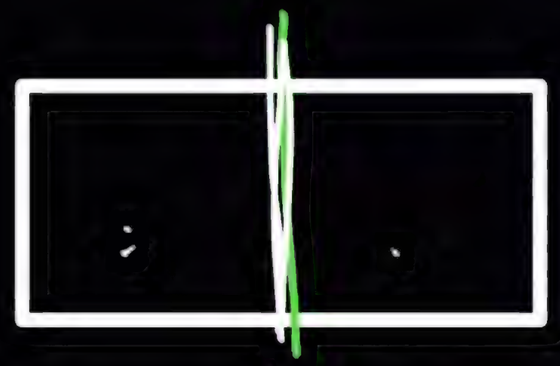
Plant cell

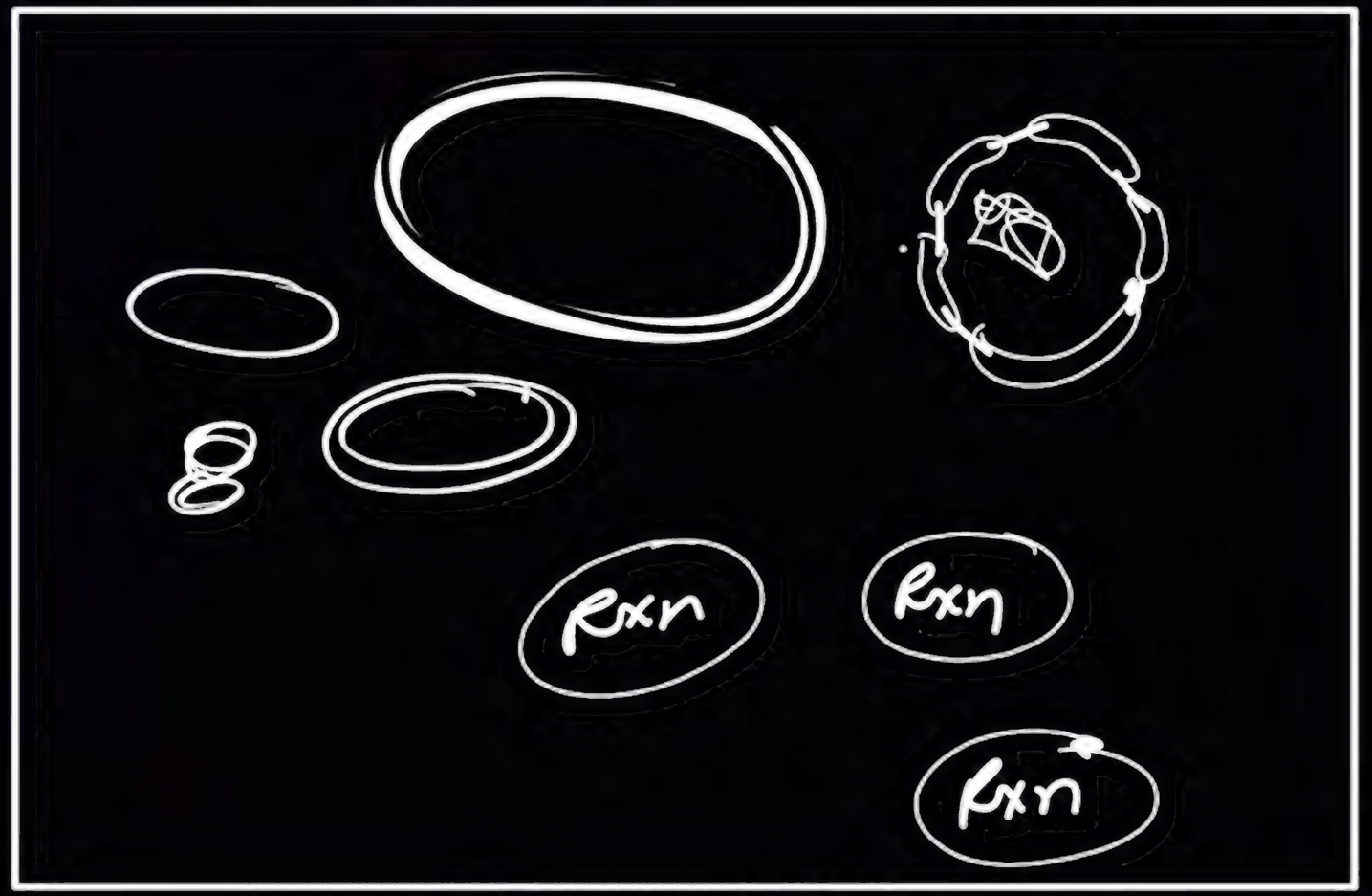
→ cell wall present (cellulose)

→ large central vacuole present

→ Centriole Absent

→ Plastids present





Eukaryotic cell

Structures need to study in Eukaryotic cell

Cell membrane

Cell wall

Endomembrane system

Endoplasmic reticulum

Golgi apparatus

Lysosomes

Vacuoles

Mitochondria

Chloroplast

Ribosomes

Cytoskeletal system

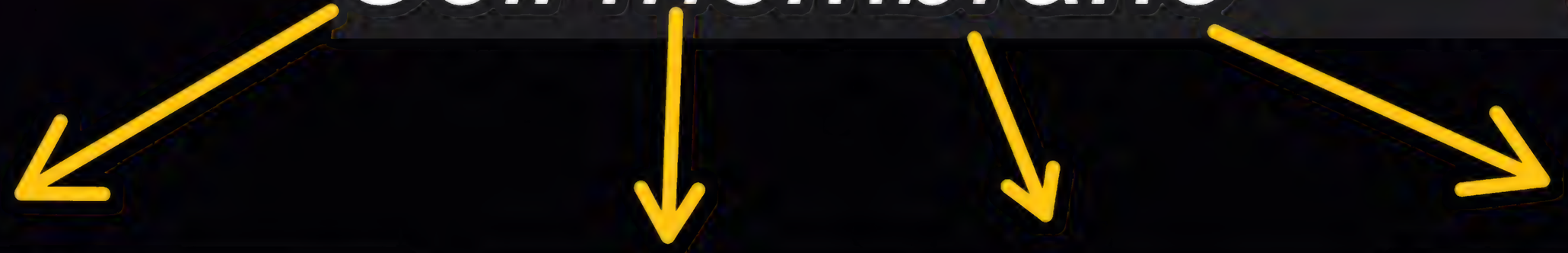
Nucleus

Nucleus

Microbodies

Cell theory

Cell membrane



Discovery

Structure

Model

Function

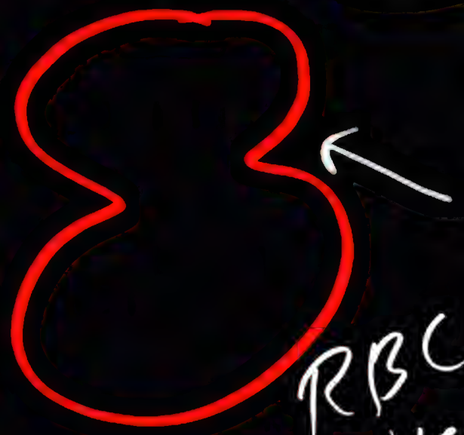
Cell membrane

(Size - jum - visible
nm = EM
visible)

→ Structurally Similar in prokaryotes & Eukaryotes
(made up of - Lipid Bilayer) ←

→ Membrane structure - detail visible only in Electron Microscope

Amoeba
(not use to study)
Membrane



RBC
use to study

Structure of cell Membrane

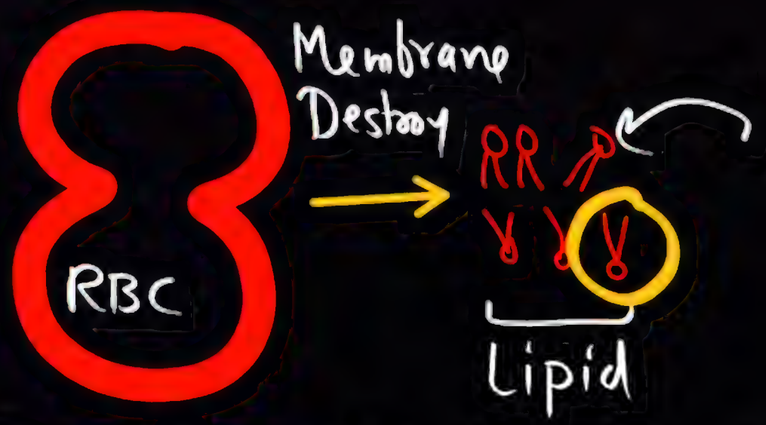
- Cell Membrane is in - all type of living cell
- detail structure only possible after - Advent of Electron microscope

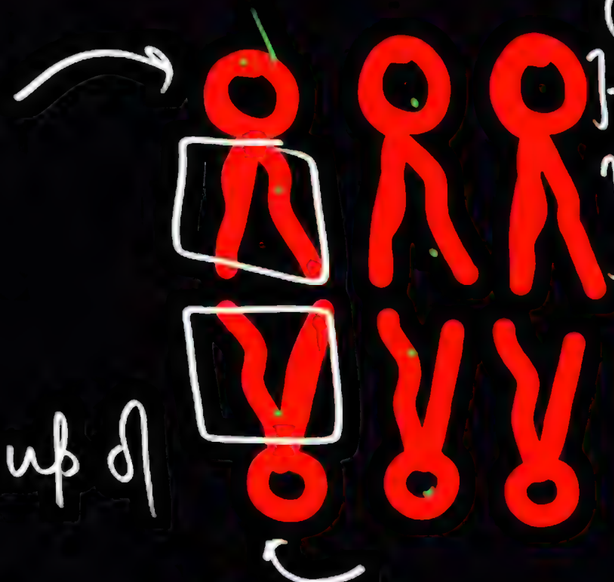
Structure of membrane - Chemical study on - RBC

RBC → Destroy (Break) → Chemical Study on RBC

Membrane Chemical study

Why RBC
↓
no membrane Bound structure
no nucleus, Mito Chondria
NO ER





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Details → (a) Membrane is mainly made up of Lipid and protein

(b) Lipid is mainly Phospholipid (Phosphoglyceride)
Example (Lecithin)

(c) Phospholipid Arrange in Form of Bilayer ✓

(d) Hydrophobic tail/part inner side
& Polar head outer side – contact with Aqueous Environment

Lipid is → Phospholipid

Glycerol

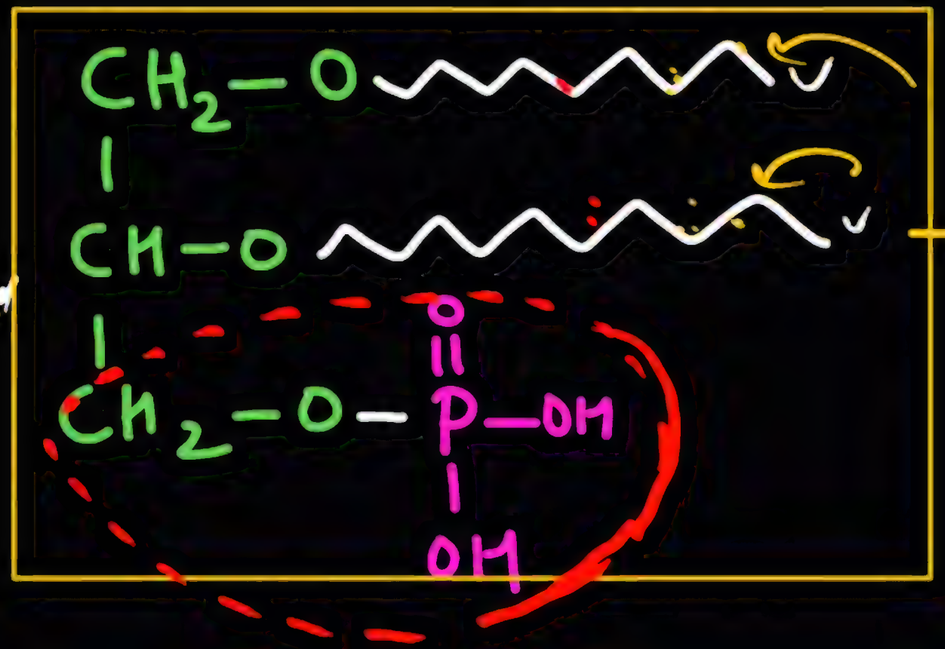
HOOC] Fatty acid

Ester Bond

1 CH_2–OH ← Fatty acid

2 CH–OH ← Fatty acid

3 CH_2–OH + Phosphate add



(Hydrophilic)
Polar head

Hydrophobic tail

Q RBC is selected For Studies because

(a) Eukaryotic

(b) No membrane Bound organelle

(c) Without nucleus

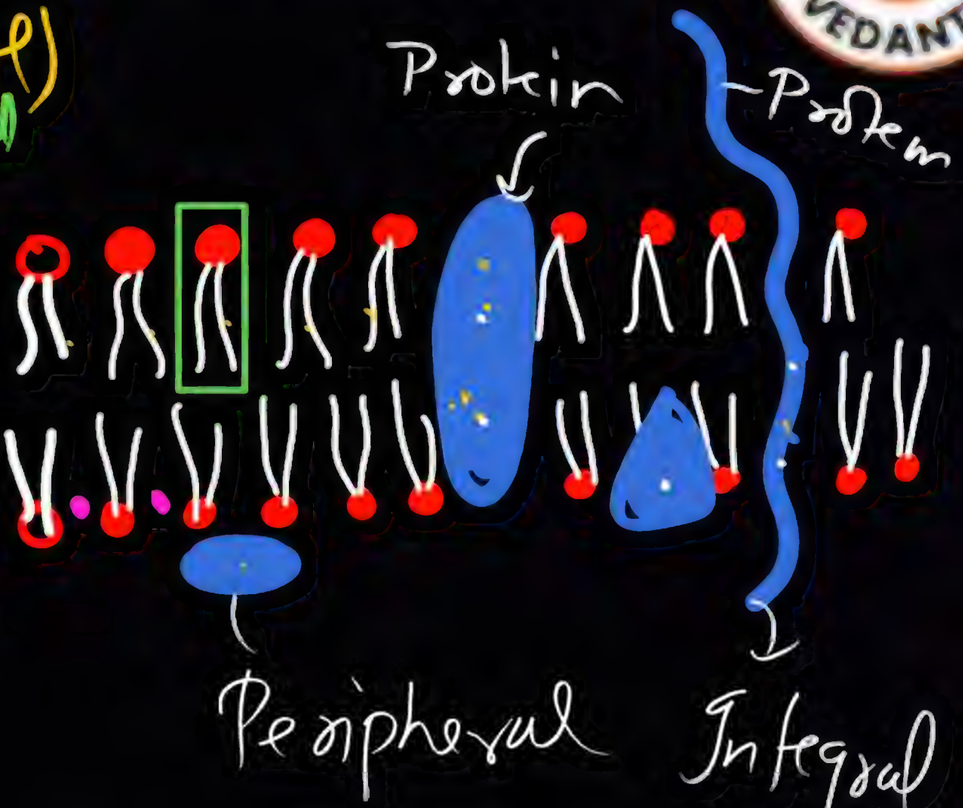
(d) all

Biochemical Analysis Give other component

→ Membrane → main lipid — Phospholipid
(But some cell also have cholesterol)
(Another lipid)

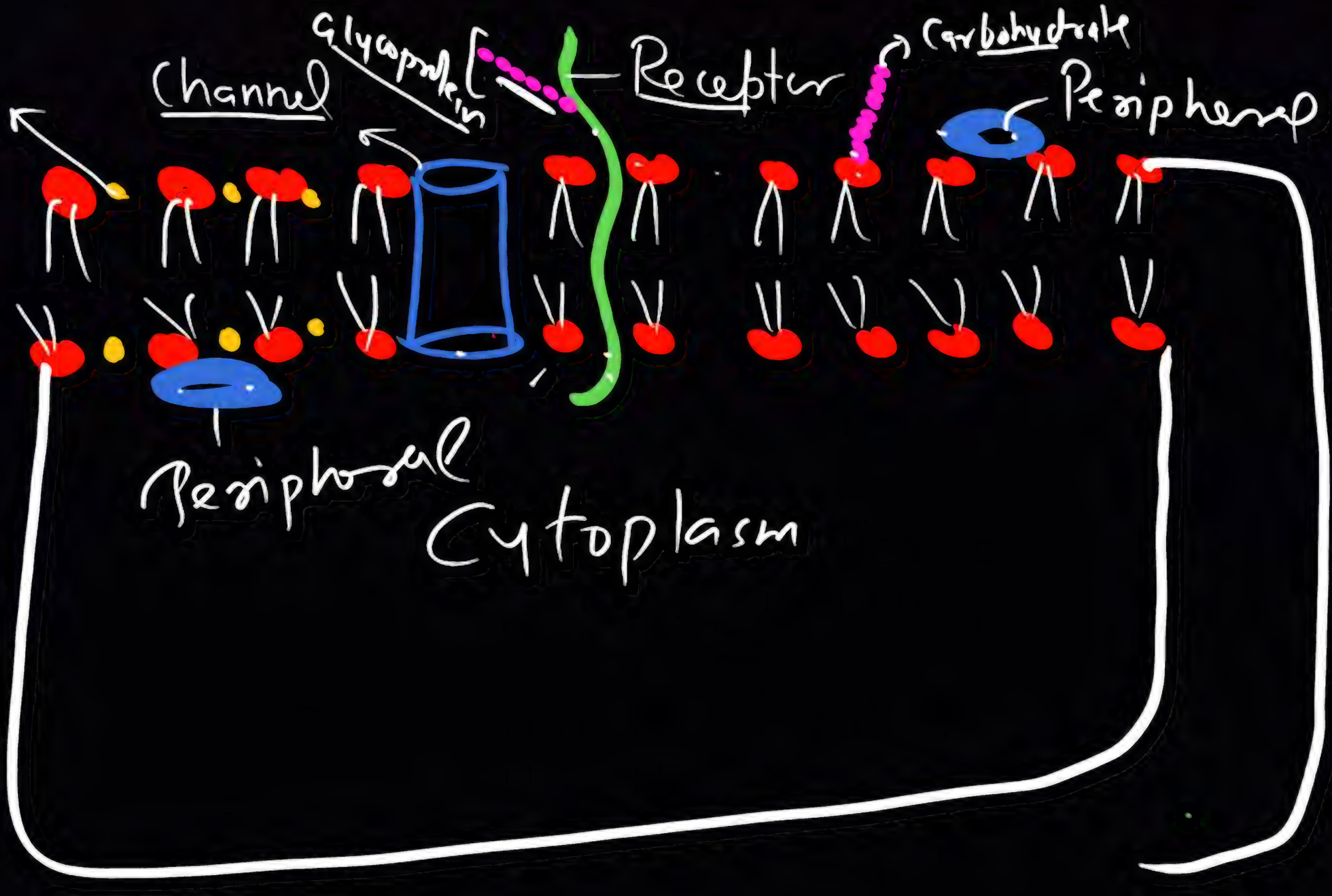
→ Proteins also present → Type of Protein
(on the Basis of Ease of Extraction)

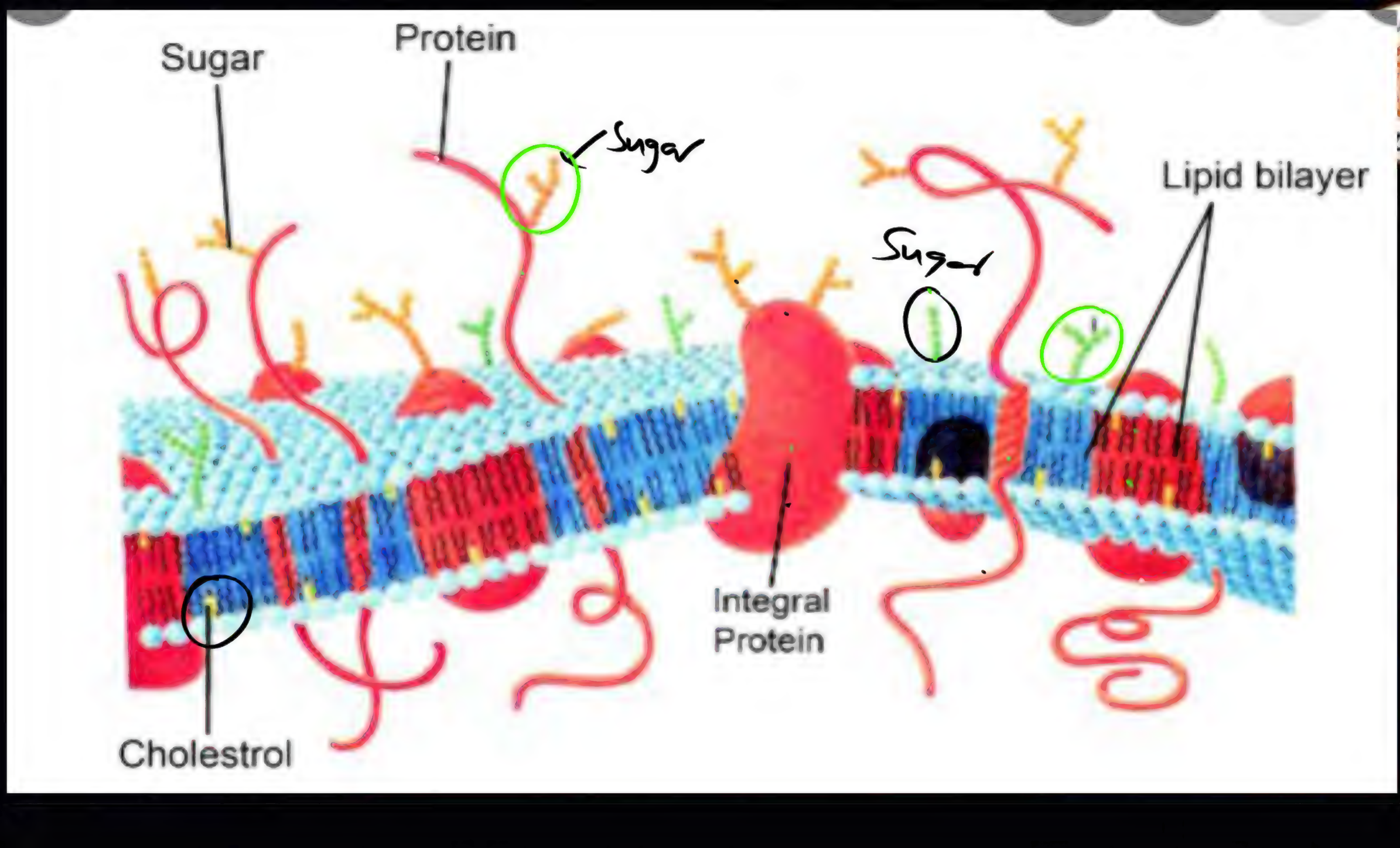
(a) Integral Protein - Difficult to Remove
(Partially or Fully Buried in membrane)
Ex- Channel, Receptor

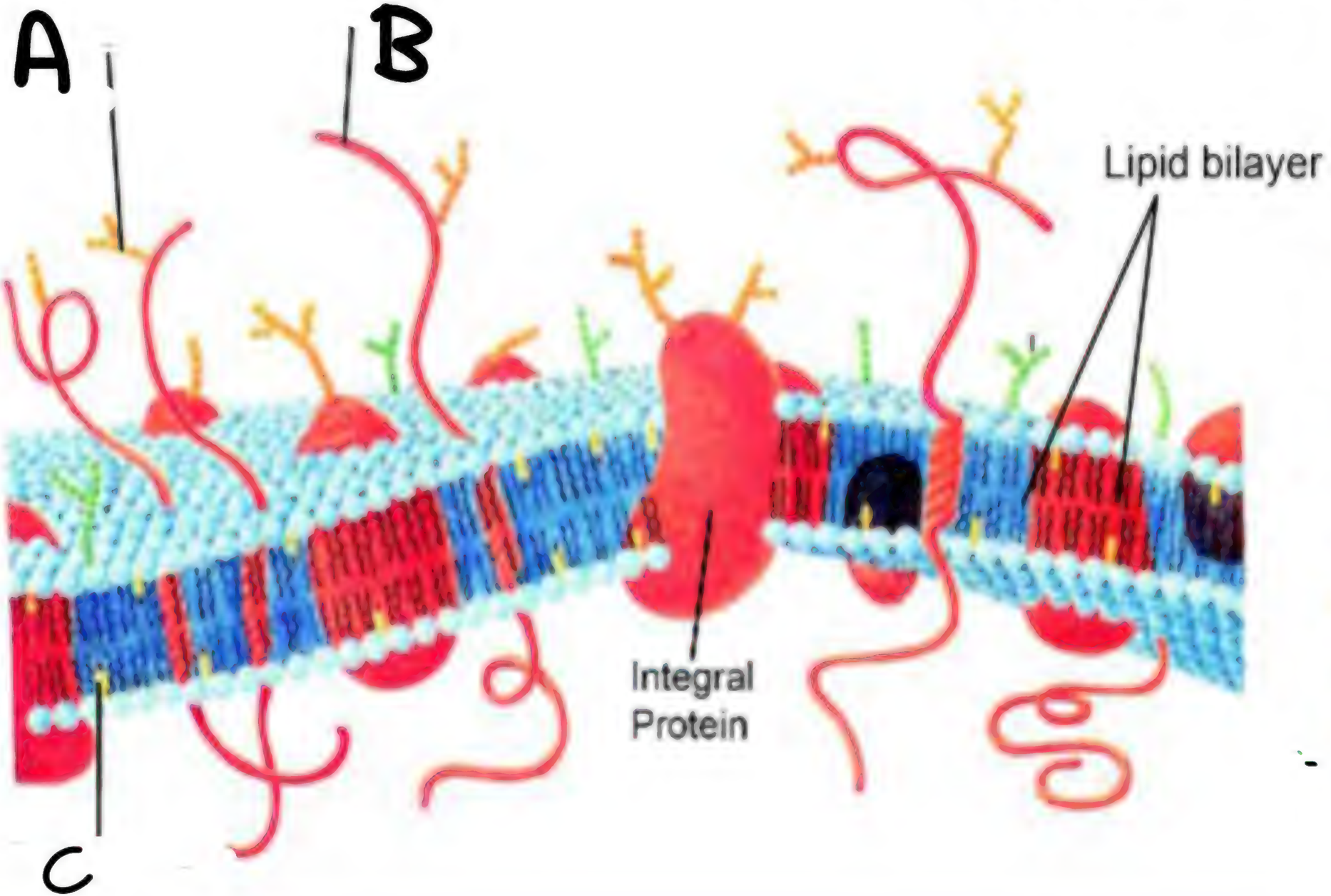


(b) Peripheral protein - Easy to Remove

[note - Carbohydrate attach on Protein = Glycoprotein
Carbohydrate attach on Lipid = Glycolipid]


Channel
Glycoprotein
Receptor
Carbohydrate
Peripheral
Peripheral
Cytoplasm


Sugar
Protein
Sugar
Sugar
Lipid bilayer
Integral
Protein
Cholestrol



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Q Diagramme 'A' Represent

(a) Protein

(b) Lipid

(c) Sugar ✓

(d) Nucleic Acid

Membrane

Lipid
- Phospholipid (main)
- Cholesterol → Animal cell only

Sugar
- Attach on protein - Glycoprotein
- Attach on lipid - Glycolipid

Protein
- Integral — Fully or partially Buried
- Peripheral → Can be Remove Easily ⇒ F_1 particle in mitochondria

RBC

Protein = 52%
Lipid = 40%
Others = 8%

Q Protein is higher in
(a) ER membrane
(b) inner membrane of Plastids
(C) Inner memb. of Mitochondria
(d) inner memb. of chloroplast

DOPA - 02

Q1 Chemical study of membrane is done on
(a) Intact RBC (b) RBC destroyed (c) Amoeba (d) all

Q2 Membrane not have
(a) lipid (b) cholesterol (c) Protein (d) Nucleic Acid

Q3 without membrane in plant cell
(a) centriole (b) ER (c) Ribosome (d) Nucleolus

Q4 Ribosome without membrane and 70 s present in
(a) Amoeba cytoplasm (b) Amoeba plastid (c) Amoeba Nucleus (d) Nostoc cell wall

Q5 Elongated structure present in
(a) Vessel (b) tracheid (c) Mesophyll (d) RBC

Q6 Major lipid in Membrane

(a) Phospholipid (b) cholesterol (c) Carbohydrate (d) Sugar

Q7 In phospholipid which is not true

(a) two Fatty acid (b) Three Fatty acid (c) Polar head (d) Hydrocarbon chain

Q8 Integral protein is not present in

(a) Fully Buried (b) Partially Buried (c) on Surface (d) Part of membrane

Q9 which is constant For membrane in percentage

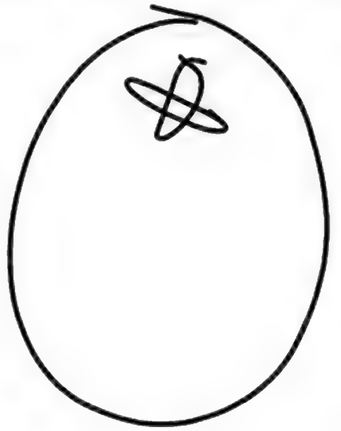
(a) cholesterol (b) lipid (c) Protein (d) none

Q10 Main phospholipid is

(a) cholesterol (b) Steroid (c) Lecithin (d) all

DOPA (1)

1. Mesosome present in
   (1) Prokaryotic cell
   (2) Plant cell
   (3) Animal cell
   (4) All



2. Smallest size present for
   (1) Ribosome
   (2) E.coli
   (3) PPLO — 0.1 μm
   (4) RBC

3. Which is common in E. coli and RBC
   (1) Mitochondria
   (2) Plasma membrane
   (3) Cell wall
   (4) All

4. Ribosome present in
   (1) Cytoplasm of prokaryotic cell
   (2) Cytoplasm of eukaryotic cell
   (3) Some organelle
   (4) All

5. Not true about centriole
   (1) Proteinaceous
   (2) Without membrane
   (3) Present in Nostoc
   (4) Present in Animal cell

6. Without Membrane organelle present in prokaryotic
   (1) Centriole
   (2) Nucleolus
   (3) Ribosome
   (4) all

6. Without Membrane organelle present in prokaryotic
(1) Centriole
(2) Nucleolus
(3) Ribosome
(4) all

7. Size of Smallest prokaryotic cell PPLO
(1) 0.1mm
(2) 3mm
(3) 3 µm
(4) 03 µm (0·3 µm)
0·3 µm
0·1 µm

8. Not true About Amoeba — Eukaryotic cell, Animal
(1) No cell wall
(2) Eukaryotic
(3) Have nucleus.
(4) Not have nucleolus — Present in all Eukaryo
(4)

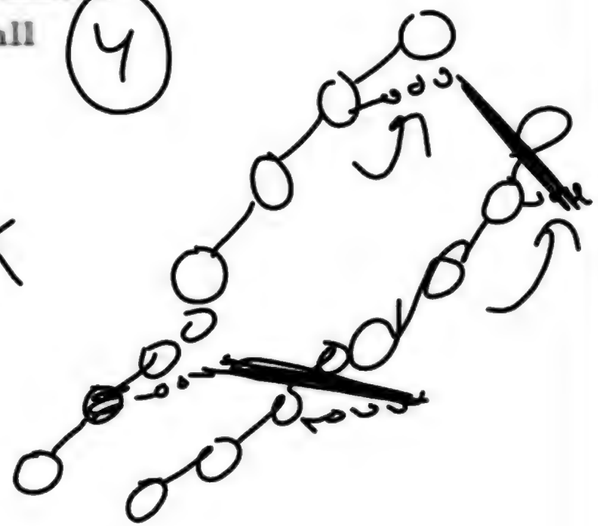
9. Nucleus observed in
(1) Plant Cell
(2) Animal cell
(3) Cheek ~~all~~ cell
(4) All

10. Flagella of Bacteria
(1) Present in all cell X
(2) With membrane X
(3) Help in motility
(4) All
(3)

Cell The Unit Of Life

(Botany)

11. Glycocalyx is present
(1) Outer to cell Membrane
(2) Inner to mesosome
(3) Part of cell wall
(4) Outer to cell wall



12. Which is present in all bacteria
(1) Pilli
(2) Flagella
(3) Genomic DNA (Nucleoid)
(4) 80 S ribosome

13. NAG & NAM are present in
(1) Cellulose
(2) Chitin
(3) Peptidoglycan
(4) All

14. Penicillin not effective against (Gram -ve)
(1) E.coli
(2) Streptomyces
(3) Frankia
(4) PPLO → Gram -ve

15. Cross linking in peptidoglycan is made up of
(1) Peptide
(2) α(1-4)
(3) β(1-4)
(4) All

16. Which enzyme break bacterial cell wall?

(1) Chitinase
(2) Cellulose
(3) Lysozyme
(4) All

17. E. coli is Gram -ve as it

(1) Not have cell wall
(2) Thick cell wall
(3) Thin cell envelop — thin
(4) All

Gram -ve — E.coli, Cyanobacli

18. Which is Gram +ve bacteria

(1) E.coli
(2) Frankia (2)
(3) Nostoc
(4) Anabena

19. Not true for cell envelop

(1) Chemically complex
(2) Protection
(3) Loosely bound layer tightly
(4) Three layer

20. Which is not carbohydrate

(1) Cellulose
(2) Chitin
(3) Peptidoglycan
(4) Cell Membrane (lipid Bilayer

Cell The Unit Of Life

(Botany)

21. S-I All Prokaryotic cell have plasmid
S-II All prokaryotic cell have nuclevid
(1) Only S-I correct
(2) only S-II correct
(3) Both S-I & S-II correct
(4) Both wrong

22. S-I Ribosome absent in Nostoc
S-II Chrome tophore present in Nostoc.
(1) Only S-I correct
(2) only S-II correct
(3) Both S-I & S-II correct
(4) Both wrong

23. S-I Mesosome and Chrometophore both involve in Respiration
S-II Mesosome involve in cell wall formation
(1) Only S-I correct
(2) only S-II correct
(3) Both S-I & S-II correct
(4) Both wrong

24. S-I Anabena have chrometophore
S-II Anabena is non-motile
(1) Only S-I correct
(2) only S-II correct
(3) Both S-I & S-II correct
(4) Both wrong

25. S-I Chrome tophore is analogous to lamellae of Chloroplast
S-II All photosynthetic Bacteria have Chlorophyll
(1) Only S-I correct
(2) only S-II correct
(3) Both S-I & S-II correct
(4) Both wrong

24. S-I Anabena have chrometophore
S-II Anabena is non-motile
(1) Only S-I correct
(2) only S-II correct
(3) Both S-I & S-II correct
(4) Both wrong

25. S-I Chrome tophore is analogous to lamellae of Chloroplast
S-II All photosynthetic Bacteria have Chlorophyll
(1) Only S-I correct
(2) only S-II correct
(3) Both S-I & S-II correct
(4) Both wrong

26. Prokaryotic cell not have
(1) Plasmid
(2) Mososome
(3) Flagella
(4) Histones

27. Not true for Nucleoid
(1) Main genomic DNA
(2) Circular
(3) Single Strand DNA
(4) Double stranded

28. PPLO not have
(1) Cell wall
(2) Flagella
(3) Nucleoid
(4) Both a & b

29. E.coli not have
(1) Cell wall
(2) Flagella
(3) Chl a
(4) Saprophytic nutrition

(Botany)

30. Flagella of bacteria is
(1) Absent in coccus
(2) Not present in nostoc
(3) Not involve microtubule
(4) All

31. rRNA is part
(1) Ribosome
(2) mRNA
(3) Inclusion Body
(4) All

32. Not true for inclusion body
(1) Without membrane
(2) Soluble
(3) Lie in cytoplasm
(4) Storage

33. Type of ribosome in cytoplasm in prokaryotes
(1) 80S
(2) 70S
(3) 50s
(4) All

34. Nuclear Envelop is not present in
(1) Mesophyll
(2) Lactobaccilus
(3) Saccharomyces
(4) Amoeba

35. Which is not present in cytoplasm?
(1) Glycocalyx
(2) Nucleoid
(3) Ribosome
(4) Inclusion Body

36. PPLO not have
(1) Cell Membrane
(2) Ribosome
(3) Nuclesid
(4) Peptidoglycan

36. PPLO not have

(1) Cell Membrane
(2) Ribosome
(3) Nuclesid
(4) Peptidoglycan

37. Gene is located on

(1) Nucleoid
(2) Ti plasmid
(3) R-plasmid
(4) All

38. Agrobacterium not have

(1) Ti plasmid
(2) Nucleoid
(3) R-plasmid
(4) Ribosome

39. _____structure present on membrane in prokaryotic cell

(1) Cell wall
(2) Nucleoid
(3) Inclusion body
(4) Ribosome

Cell The Unit Of Life

(Botany)

40. Structure common in plant cell & animal cell

(1) Ribosome
(2) Centriole
(3) Cell wall
(4) Plastid

Ribosome = 80s

MANTHAN NEET 2025

SANKALP NEET VEDANTU

cell unit of life

lecture - 05

Botany

TARUN SIR

DOPA - 02

Q1 Chemical study of membrane is done on
(a) Intact RBC (b) RBC destroyed (c) Amoeba (d) all

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(a) lipid (b) cholesterol (c) Protein (d) Nucleic Acid

Q3 without membrane in plant cell c, d
(a) Centriole (b) ER (c) Ribosome (d) Nucleolus

Q4 Ribosome without membrane and 70 s present in
(a) Amoeba Cytoplasm (b) Amoeba plastid (c) Amoeba Nucleus (d) Nostoc cell (Rock
80s

Q5 Elongated structure present in
(a) Vessel (b) tracheid (c) Mesophyll (d) RBC

Q6 Major lipid in Membrane

(a) Phospholipid (b) cholesterol (c) Carbohydrate (d) Sugar

Q7 In phospholipid which is not true

(a) two Fatty acid (b) Three Fatty acid (c) Polar head (d) Hydrocarbon chain

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(a) Fully Buried (b) Partially Buried (c) on Surface (d) Part of membrane

Q9 which is constant For membrane in percentage

(a) cholesterol (b) Lipid (c) Protein (d) none

Q10 Main phospholipid is

(a) cholesterol (b) Steroid (c) Lecithin (d) all

Structures need to study in Eukaryotic cell

Cell membrane

Cell wall

Endomembrane system

Endoplasmic reticulum

Golgi apparatus

Lysosomes

Vacuoles

Mitochondria

Chloroplast

Ribosomes

Cytoskeletal system

Nucleus

Microbodies

Cell theory

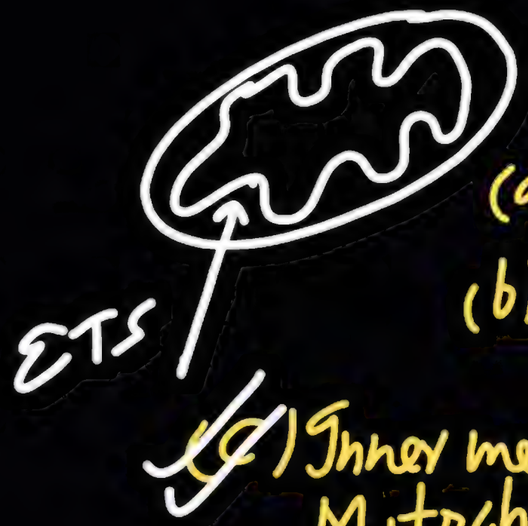
Membrane

- Lipid
  - Phospholipid
  - Cholesterol
- Sugar
  - Glycoprotein
  - Glycolipid
- Protein
  - Integral ✓
  - Peripheral ✓

note - More percentage of protein, more Active is membrane

RBC

Protein - 52%.
Lipid - 40%.
Others



Q Protein is higher in

(a) ER membrane

(b) inner membrane of Plastids

(c) Inner memb. of Mitochondria

(d) inner memb. of chloroplast

8.5.1 Cell Membrane

The detailed structure of the membrane was studied only after the advent of the electron microscope in the 1950s. Meanwhile, chemical studies on the cell membrane, especially in human red blood cells (RBCs), enabled the scientists to deduce the possible structure of plasma membrane.

These studies showed that the cell membrane is mainly composed of lipids and proteins. The major lipids are phospholipids that are arranged in a bilayer. Also, the lipids are arranged within the membrane with the polar head towards the outer sides and the hydrophobic tails towards the inner part. This ensures that the nonpolar tail of saturated hydrocarbons is protected from the aqueous environment (Figure 8.4). In addition to phospholipids membrane also contains cholesterol.

Later, biochemical investigation clearly revealed that the cell membranes also possess protein and carbohydrate. The ratio of protein and lipid varies considerably in different cell types. In human beings, the membrane of the erythrocyte has approximately 52 per cent protein and 40 per cent lipids.

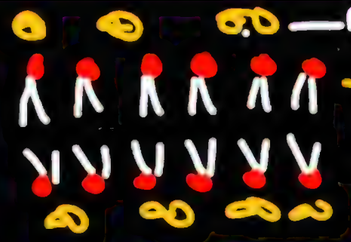
Depending on the ease of extraction, membrane proteins can be classified as integral and peripheral. Peripheral proteins lie on the surface of membrane while the integral proteins are partially or totally buried in the membrane.

Models of Membrane structure

- Globular
- Fibrous

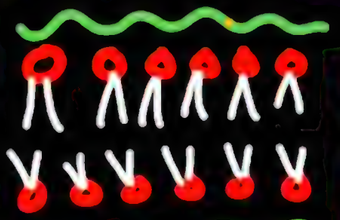
Match the Following

① Daniel Davison



} Lipid Bilayer + Globular protein

② Robertson →



→ Lipid Bilayer + Fibrous Protein
Unit membrane model

note - Models Explain how Lipid & protein Arrange

③ Singer and Nicolson – Fluid mosaic model
(1972) (Scientist)

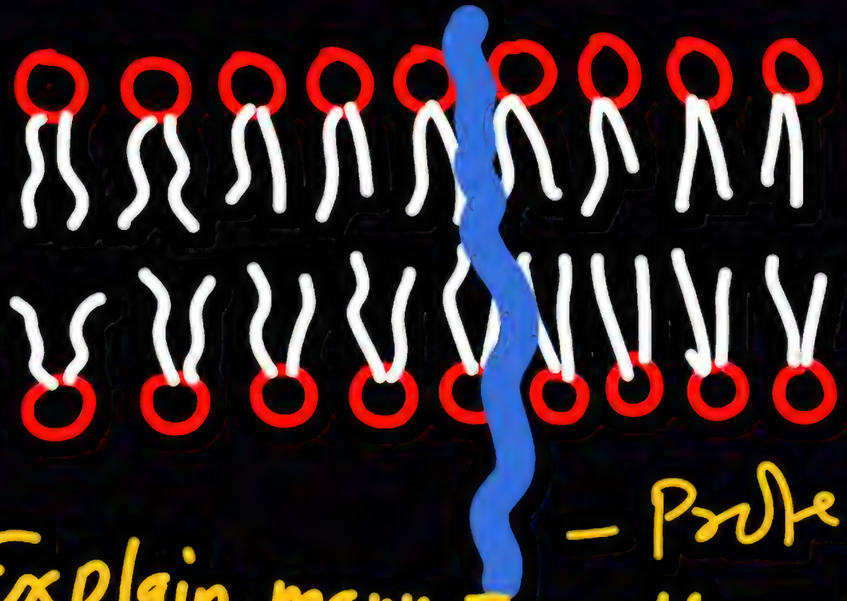
- Lipid Bilayer Form
- Protein present Both on surface & inside Membrane

Singer and Nicolson model

Important point – lipid is like Quasi fluid in nature

– Protein can move laterally

Ability of protein to move laterally is known as **Fluidity** ✓

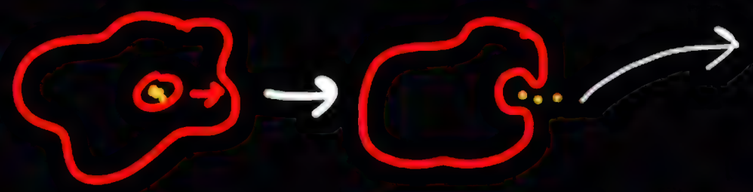


Quasi fluid nature of Membrane Explain many Function of Membrane

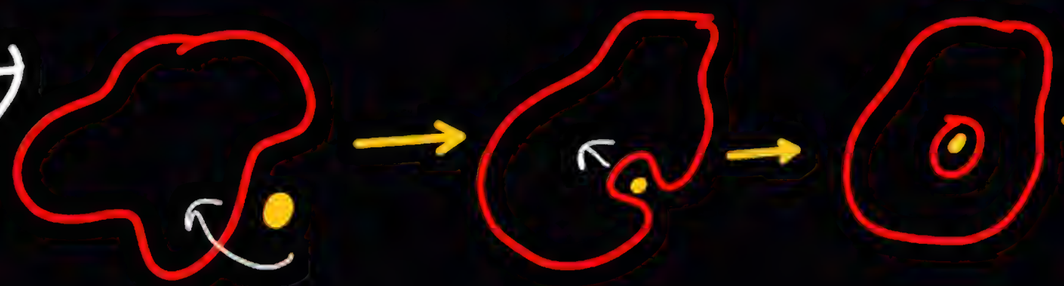
(a) Cell Growth
(b) Cell Division
(c) inter cellular Junction
(d) Secretion
(e) Phagocytosis

Fluid nature also Explain

1. Growth – Since Membrane is made up of lipid, new lipid molecule become its part → Responsible For Growth of membrane
2. Cell Division – Since Membrane is of lipid → Quasi fluid nature → It can Fold Easily → Cell Divide
3. Intercellular Junction – Due to protein present on Membrance
4. secretion →

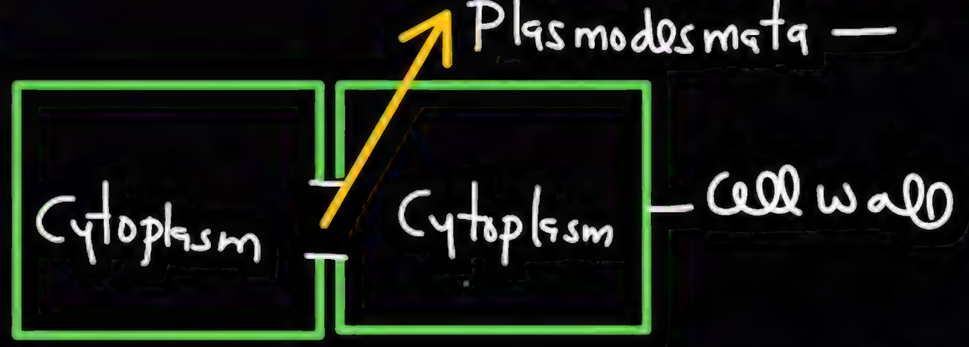


5. Endocytosis →



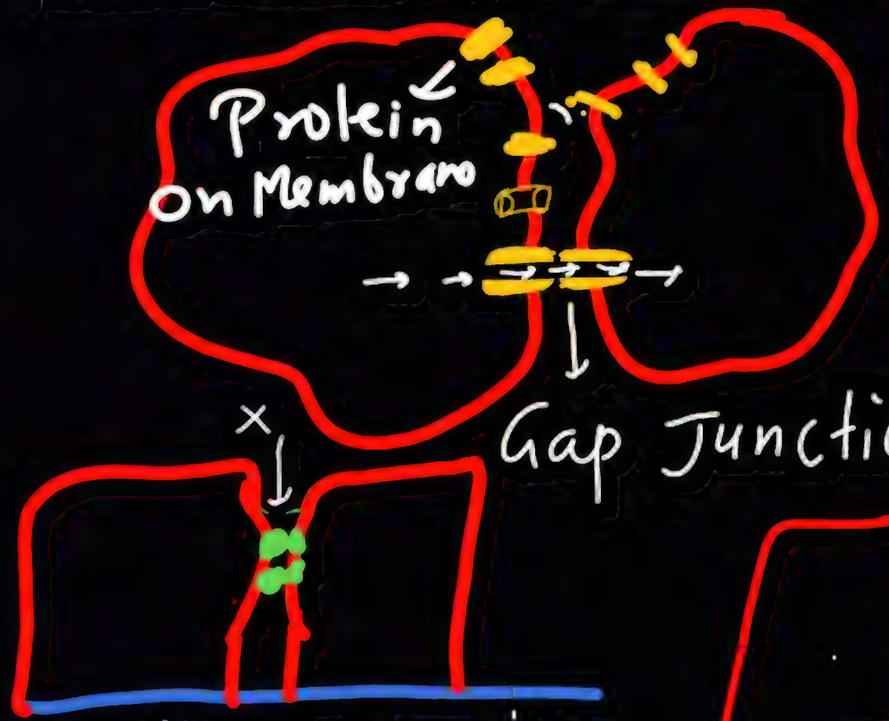
} Secretion & Endocytosis Possible only When membrane is Quasi fluid

Plant cell



In plants, two cell Cytoplasm Can connect Directly

Animal cell → Plasmodesmata Absent, Junctions present B/w two cell

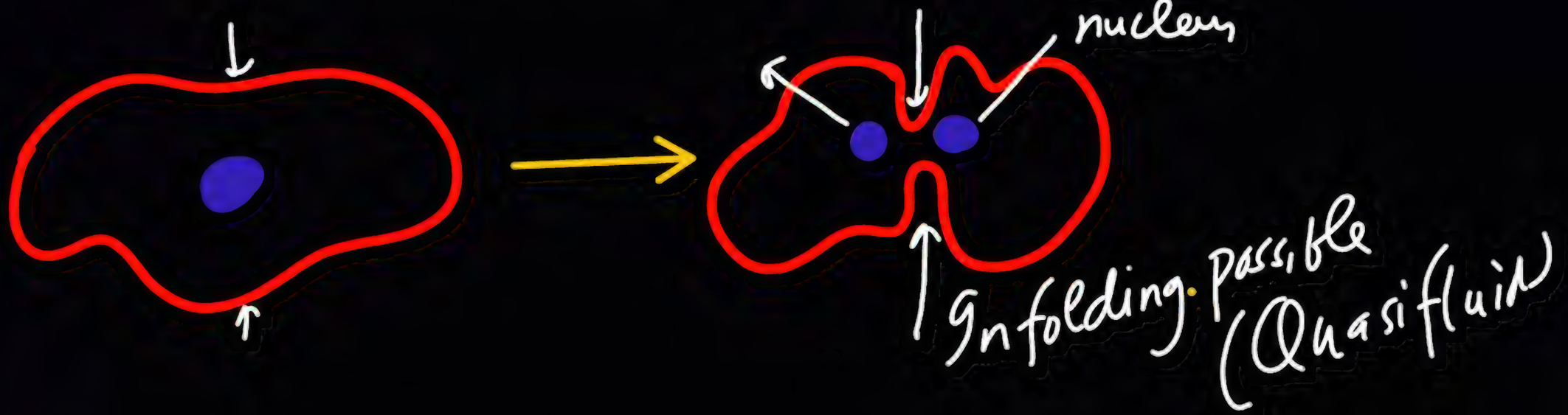


(a) Gap Junction – two protein of two cell come in contact & Foorm a Cytoplasmic connection

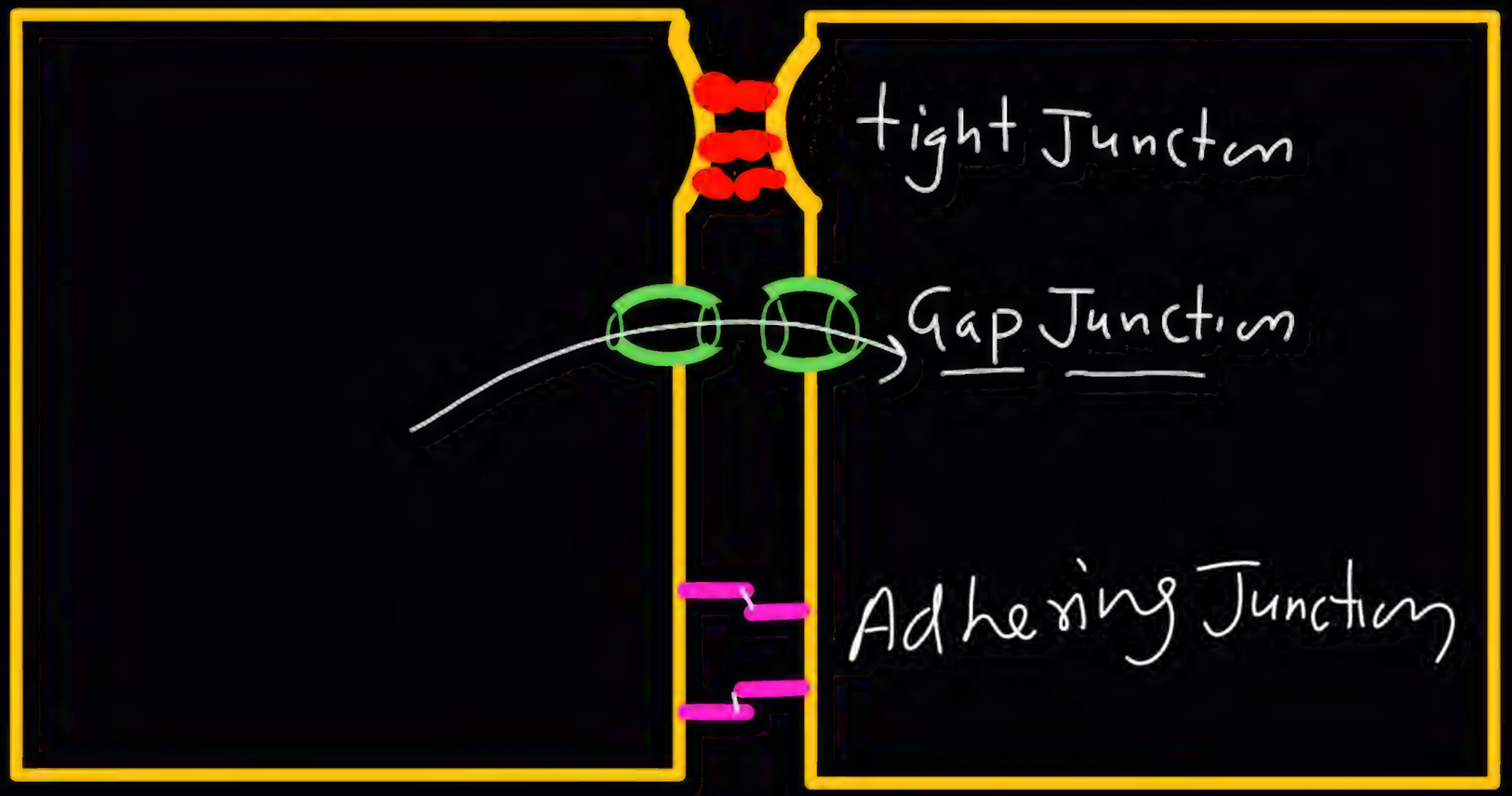
(b) Adhering Junction – Connect two cell

(c) tight Junction – Prevent leakage

H2O
H2O
Cell Growth
Lipid
Cell Membrane


nucleus
Infolding possible
(Quasifluin

Intercellular junction

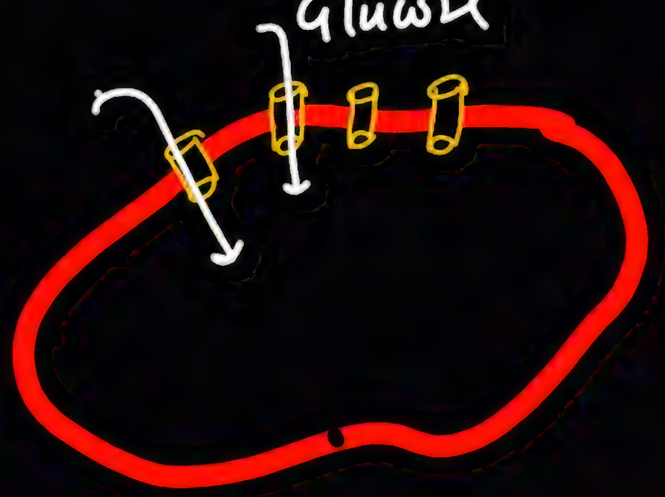


Transport across membrane

Two type of Transport

Bulk transport → large size substance move inside cell

Specific transport → Glucose, water, Gas (Specific Substance move)



Bulk transport

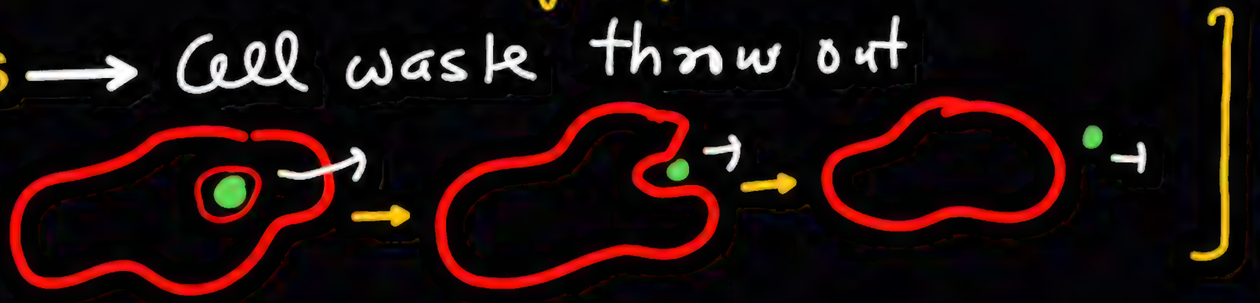
Endocytosis → large Substance → Food, Bacteria can Enter into Cell

→ Two type → (a) Phagocytosis (Cell Eating) (solid substance Enter)

(b) Pinocytosis (Cell Drinking) (Liquid Enter)

Phagocytosis

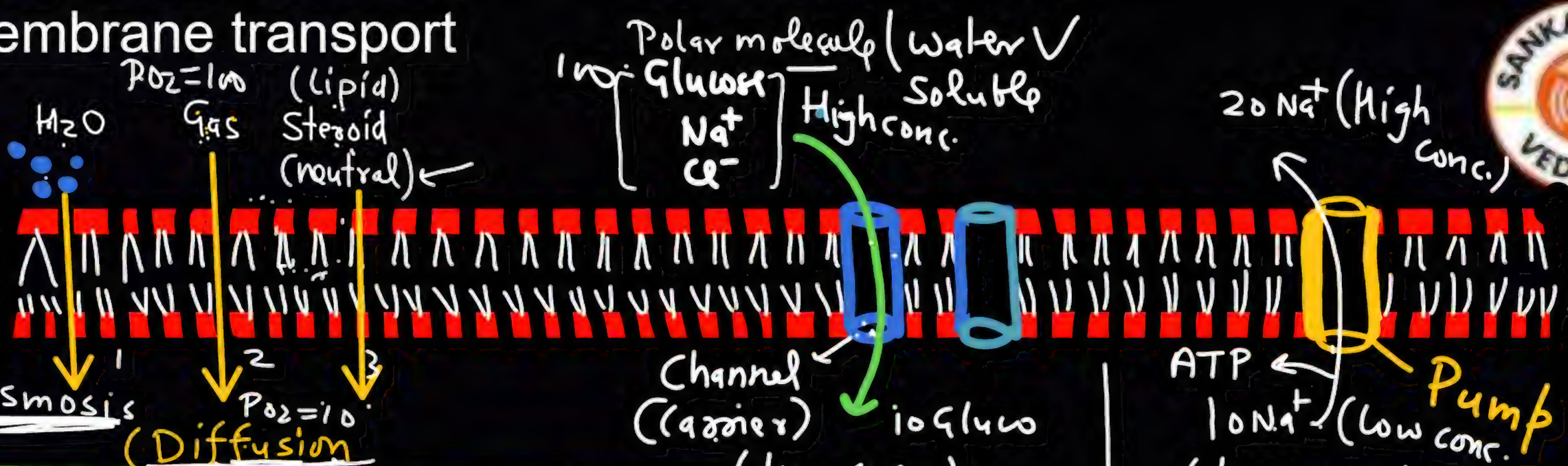
Exocytosis → Cell waste throw out



Example → Enzymes From Glands

→ Waste By Amoeba

Membrane transport



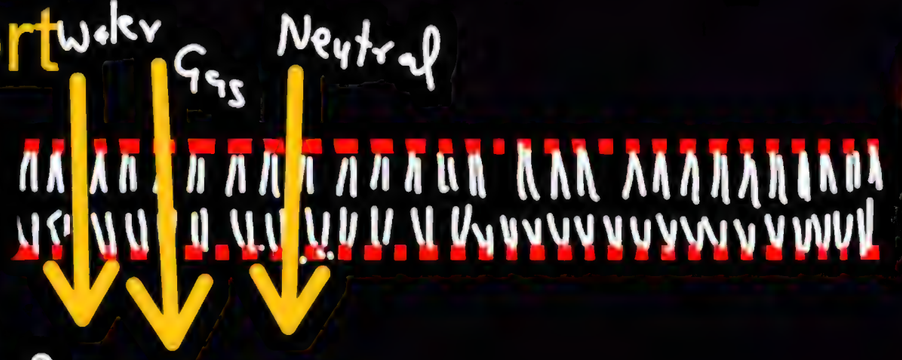
Membrane – Two type transport

(a) Bulk transport (Endocytosis, Exocytosis)

(Facilitated Diffusion)

(Active transport

Specific transport



Gas ——→ By Diffusion (High conc. to low conc.)

Neutral molecule → like lipid – Diffusion

Water ——→ High conc. of water ——→ low conc. of water (Salt more) (Hypertonic)

(Diffusion is known as osmosis) (Hypotonic)

Polar molecule →

By carrier – Passive transport

– High conc. to low conc. → Direction

– No ATP Require (Along conc. gradient)

By Pump → Active transport / ATP Require

low conc. to high conc. (Against conc. gradient)

Ex – Na^+–K^+ Pump (Neuron)

Type of transport

	Conc. gradient	Protein involve	ATP	Example
simple diffusion	High to low (Along conc. gradient)	Channel or pump not involve	not Require Passive	– Gas – H_2O (osmosis) – Neutral (Steroid hormone)
Facilitated Diffusion	High to low (Along conc. gradient)	Channel ✓ involve	Not Require Passive transport	Ex – Na^+ – Channel Glucose channel (Glut-4)
Active Transport	low conc to high Against conc. gradient	Pump involve	Yes Active process	$Na^+ - K^+$ Pump

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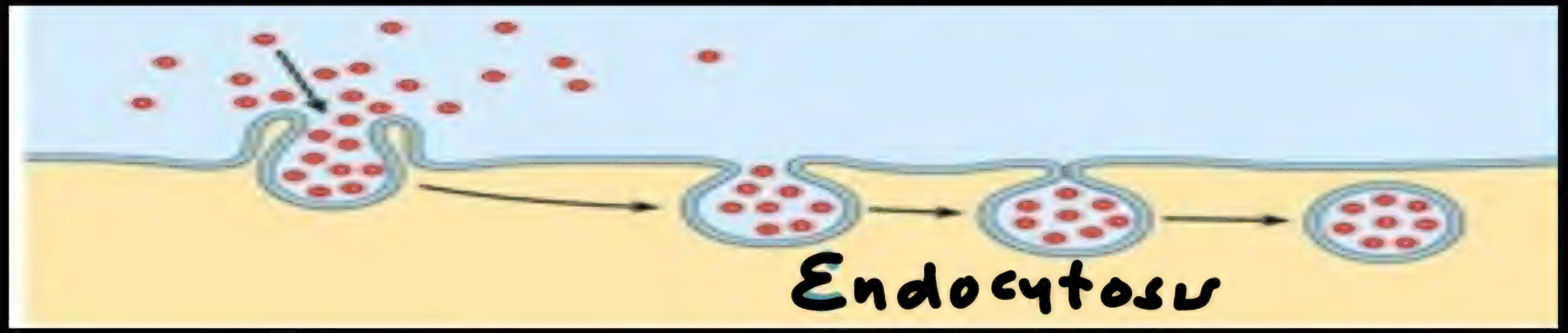

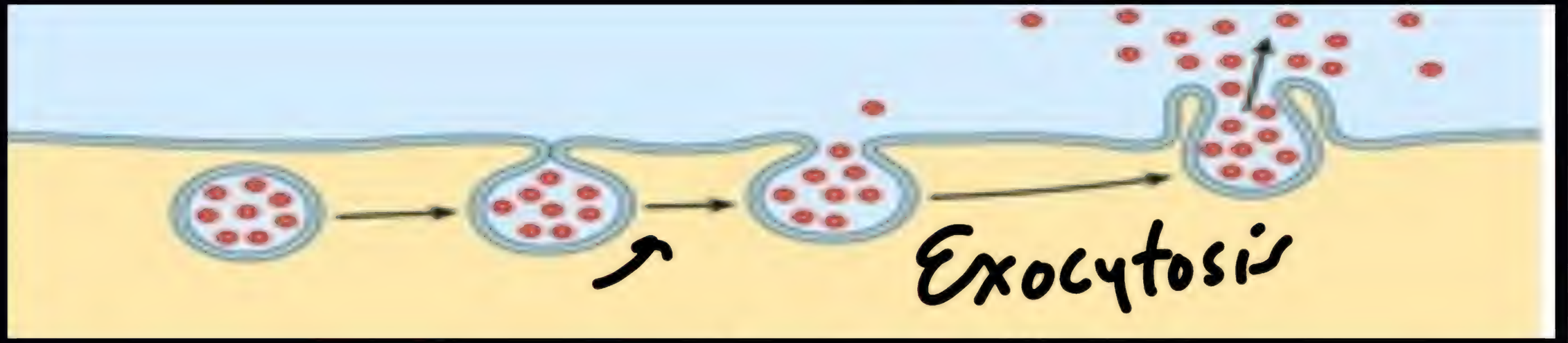

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An improved model of the structure of cell membrane was proposed by Singer and Nicolson (1972) widely accepted as **fluid mosaic model** (Figure 8.4). According to this, the quasi-fluid nature of lipid enables lateral movement of proteins within the overall bilayer. This ability to move within the membrane is measured as its fluidity.

The fluid nature of the membrane is also important from the point of view of functions like cell growth, formation of intercellular junctions, secretion, endocytosis, cell division etc.

Q Which is not modification of membrane

I Porins
II Mesosomes
III Microvilus
IV Cell Junctions
V Villi

Select correct option

(a) I & II
(b) I, II, IV
(c) I, II, III & IV
(d) all

One of the most important functions of the plasma membrane is the transport of the molecules across it. The membrane is selectively permeable to some molecules present on either side of it. Many molecules can move briefly across the membrane without any requirement of energy and this is called the **passive transport**. Neutral solutes may move across the membrane by the process of simple diffusion along the concentration gradient, i.e., from higher concentration to the lower. Water may also move across this membrane from higher to lower concentration. Movement of water by diffusion is called **osmosis**. As the polar molecules cannot pass through the nonpolar lipid bilayer, they require a carrier protein of the membrane to facilitate their transport across the membrane. A few ions or molecules are transported across the membrane against their concentration gradient, i.e., from lower to the higher concentration. Such a transport is an energy dependent process, in which ATP is utilised and is called **active transport** e.g., Na^+/K^+ Pump.

DOPA -03

Q1 $Na^+ - K^+$ pump not true
(a) Active transport (b) Along conc. gradient (c) Against conc. gradient (d) ATP involve

Q2 If membrane is Selective permeable means
(a) Allow solute to pass (b) allow solvent to pass (c) allow some solute to pass (d) all no solute to pass

Q3 Facilitated Diffusion occur for
(a) Na^+ (b) Gas (c) Neutral molecule (d) all

Q4 Not Explain By Quasi fluid nature of membrane
(a) Facilitated diffusion (b) Secretion (c) cell Division (d) Growth

Q5 Membrane is
(a) Solid (b) Liquid (c) Quasi fluid (d) Fluid

Q6 Endocytosis of Solid is
(a) Phagocytosis (b) Due to Quasi fluid nature of Membrane (c) Cell Eating (d) all

Q7 Which occur last
(a) Cell theory (b) EM Discovery (c) Fluid mosaic model (d) Mendel's law Published

Q8 Ability of Protein move in membrane
(a) Rigidity (b) Fluidity (c) Endocytosis (d) all

Q9 Junction help to move substance one cell to other
(a) Adhering Junction (b) Gap Junction (c) tight Junction (d) none

Q10 Against conc. gradient movement occur in
(a) Neutral molecule (b) Pump (c) Channel (d) Carrier

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cell unit of life

lecture – 06

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Structures need to study in Eukaryotic cell

Cell membrane

Cell wall

Endomembrane system

Endoplasmic reticulum

Golgi apparatus

Lysosomes

Vacuoles

Mitochondria

Chloroplast

Ribosomes

Cytoskeletal system

Nucleus

Microbodies

Cell theory

DOPA-03

Q1 $Na^+ - K^+$ pump not true
(a) Active transport (b) Along conc. gradient (c) Against conc. gradient (d) ATP involve

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(a) Na^+ (b) Gas (c) Neutral molecule (d) all

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(a) Cell theory 1959 (b) EM Discovery 1950's (c) Fluid mosaic model 1972 (d) Mendel's law Published 1865

Q8 Ability of Protein move in membrane
(a) Rigidity (b) Fluidity (c) Endocytosis (d) all

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(a) Adhering Junction (b) Gap Junction (c) tight Junction (d) none

Q10 Against conc. gradient movement occur in
(a) Neutral molecule (b) Pump (c) Channel (d) Carrier

Cell wall

Cell wall present in – Some protist, Plantae (Cellulose) Fungi (Chitin)

[Cell wall → is considered as dead]

(Living structure) ✓

→ Cell Membrane

→ Cell wall (dead structure)

Role of cell wall

(a) Provide Support ✓

(b) Give Rigidity ✓

(c) Prevent From Bursting

(d) Prevent Entry of macromolecule

(e) Prevent From Infection

(f) Responsible For cell to cell interaction (Middle lamellae)

Plantae – Algae, Bryophyte, Pteridophyte, Gymnosperm, Angiosperm

Water — Land

→ Algae cell wall ←

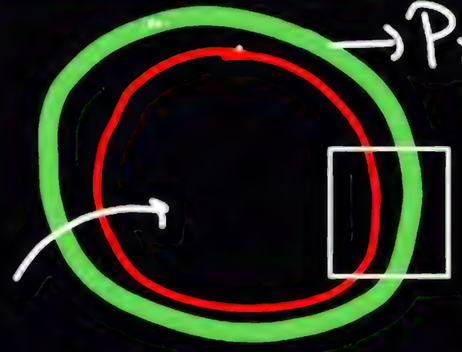
– Since Algae is Aquatic, cell wall is Slight Different From land Plants

→ Cellulose (Carbohydrate) – main component

Galactans, Mannans, $CaCO_3$ (Salt)

Carbohydrate

cell wall structure (on land)

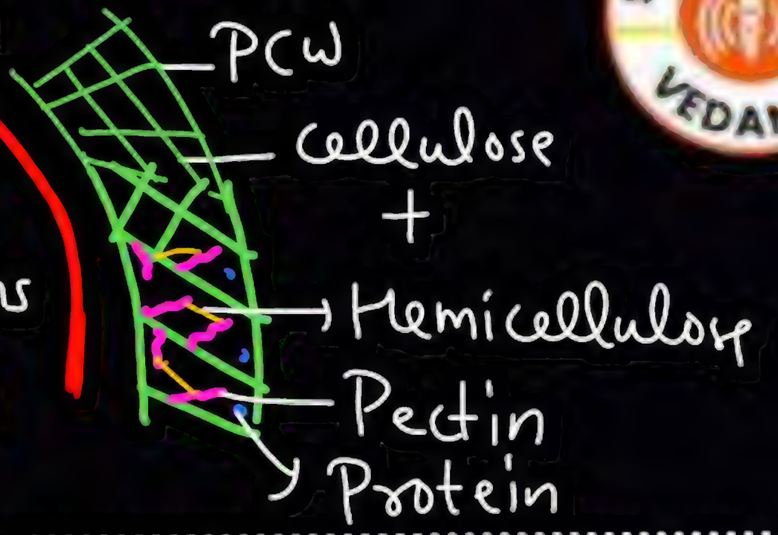


→ Primary cell wall - Present in young cells (PCW)

made up of → Cellulose + Hemicellulose + Pectin + Proteins

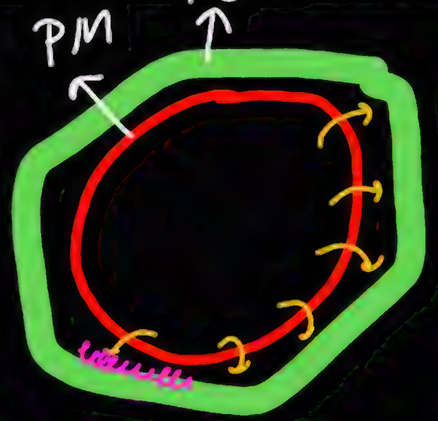
- It can grow → PCW can also diminished

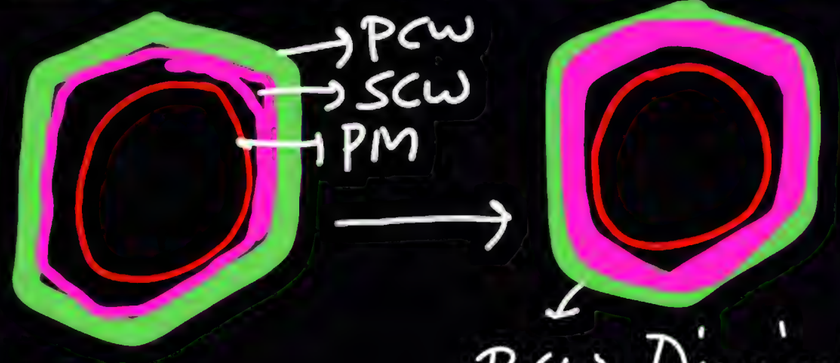
Young cell [Meristimatic, Parenchyma] →



Mature cell → Two type
- Collenchyma
- Sclerenchyma

⇒ Secondary cell wall (B/w Primary cell wall & Plasma membrane) → Chemical - Pectin, -lignin





Plant cell wall

PCW (Primary cell wall)

Location – Outermost

Cellulose + Hemicellulose
Pectin + Protein

Present in – Young cell

→ Can grow, can diminished

SCW (Secondary cell wall)

Location – Inner to PCW

mainly – Pectin or Lignin

Present in – Mature cell

- Can not Grow
- Due to which, cell can Become dead

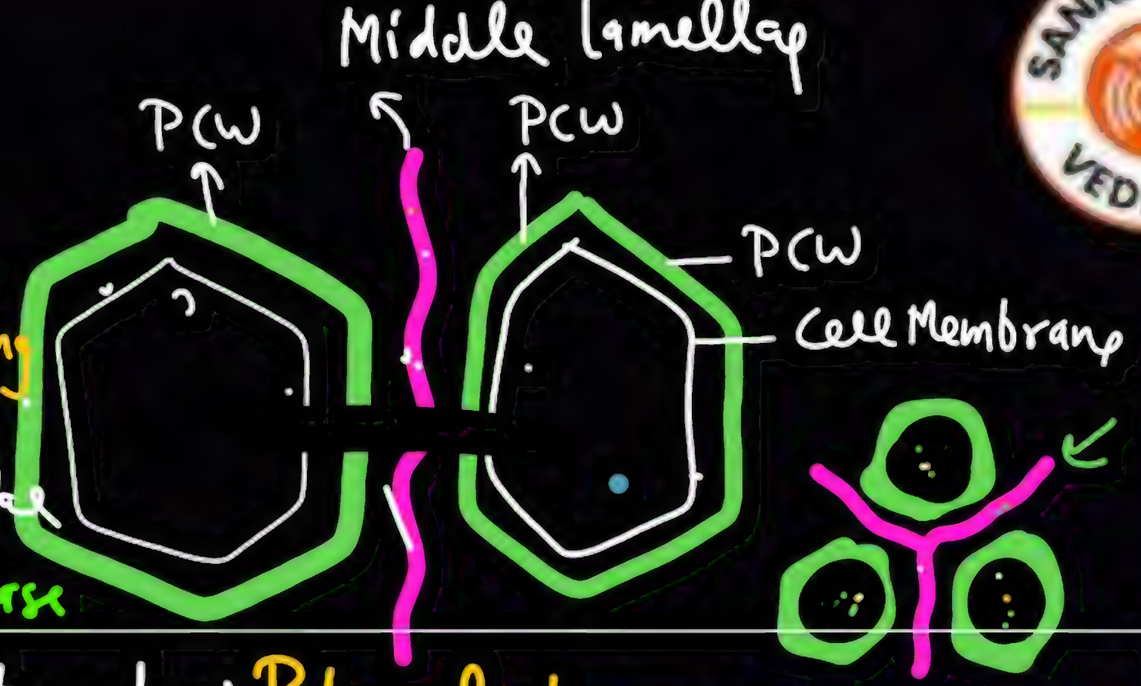
Middle lamella

→ Present B/w two neighbouring cell

→ made up of – Calcium pectate

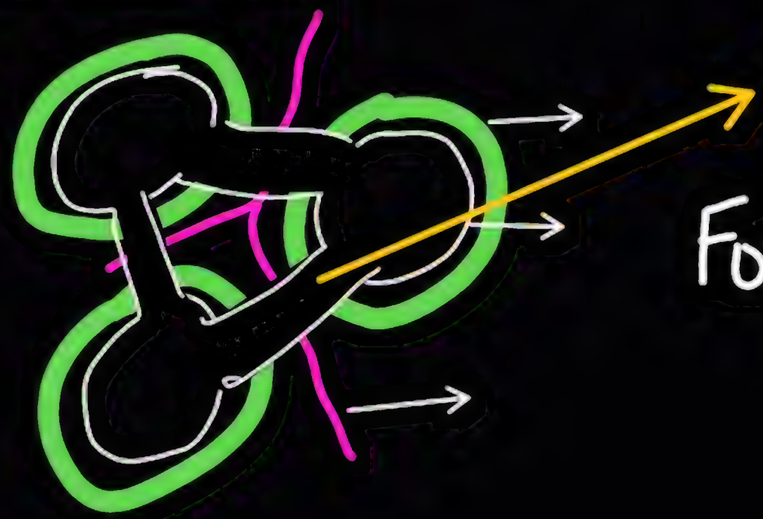
Role – It Glue/Attach two neighbouring cell

Note – Fruit Ripening – Middle lamella Digested By – Polygalactoronase



Biotech → Flavr Savr – long lasting tomato → Polygalactoronase less Active

Plasmodesmata



Plasmodesmata – Cytoplasmic Connection B/w two plant cell

Form Due to – Middle lamella + Cell wall Absent (transversed By)

8.5.2 Cell Wall

As you may recall, a non-living rigid structure called the cell wall forms an outer covering for the plasma membrane of fungi and plants. Cell wall not only gives shape to the cell and protects the cell from mechanical damage and infection, it also helps in cell-to-cell interaction and provides barrier to undesirable macromolecules. Algae have cell wall, made of cellulose, galactans, mannans and minerals like calcium carbonate, while in other plants it consists of cellulose, hemicellulose, pectins and proteins. The cell wall of a young plant cell, the **primary wall** is capable of growth, which gradually diminishes as the cell matures and the secondary wall is formed on the inner (towards membrane) side of the cell.

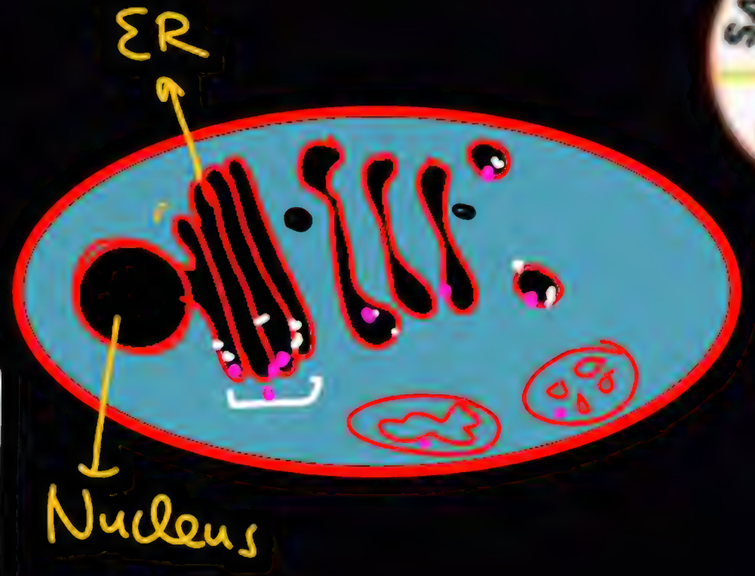
The middle lamella is a layer mainly of calcium pectate which holds or glues the different neighbouring cells together. The cell wall and middle lamellae may be traversed by plasmodesmata which connect the cytoplasm of neighbouring cells.

Endomembrane System

Inside cell — Lipid Bilayer

Many organelle is made up of membrane

[ER, Golgi bodies, vesicles, lysosome, Vacuole, Plastids, Mitochondria, Peroxisome]

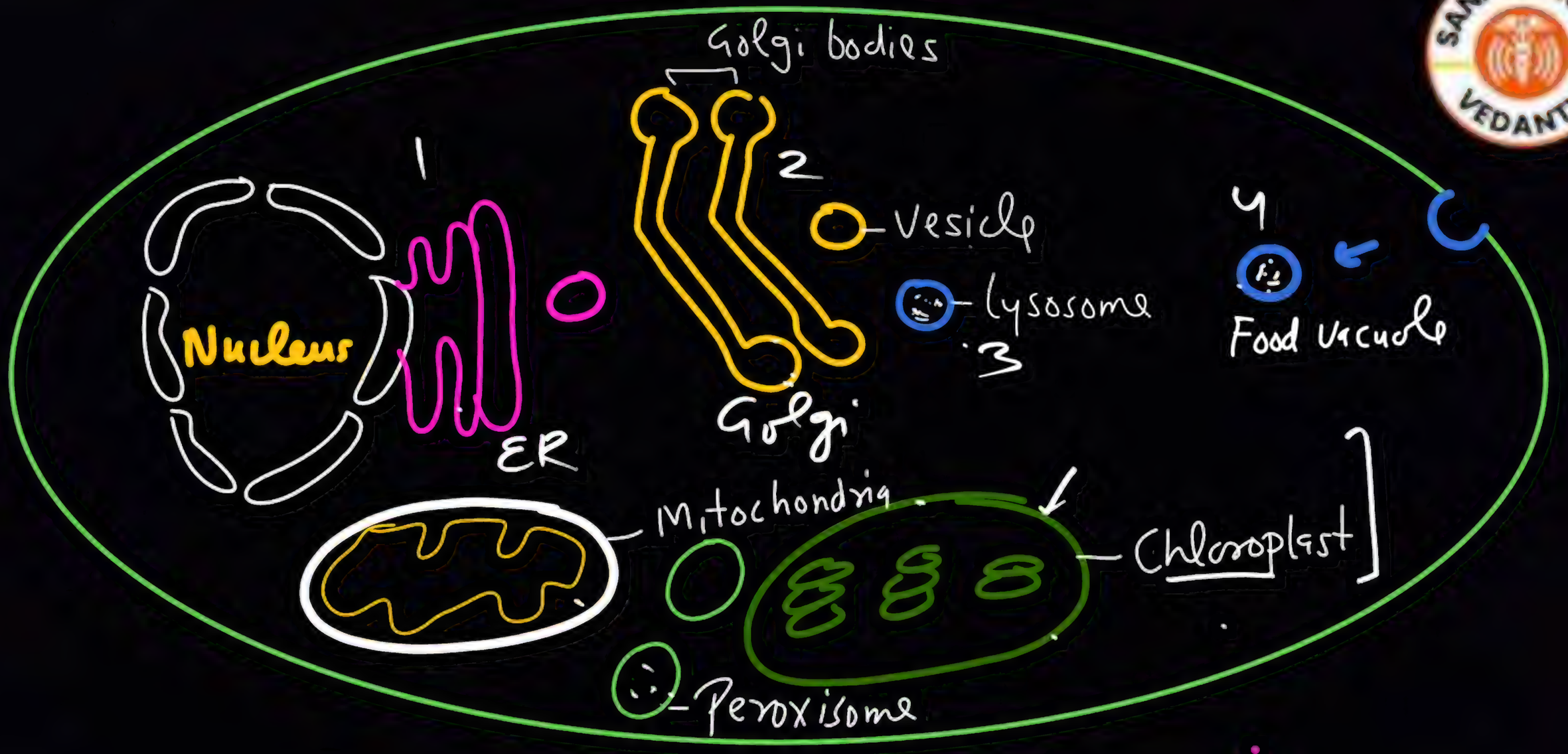


⇒ [ER, Golgi body, lysosome, vesicle, Vacuole] ← Endomembrane system

– They have membrane
Functions coordinated

[Mitochondria, Chloroplast, Peroxisomes] – have Membrane

But Functions not coordinated


Golgi bodies
1
2
Vesicle
lysosome
3
4
Food Vacuole
Nucleus
ER
Golgi
Mitochondria
Chloroplast
Peroxisome

Q1 Not true About Endomembrane system

(a) Lipid membrane

(b) Coordinated

(c) Enzyme can present — Lysosome (d)

(d) involve in photosynthesis ✗

Q2 Plastids are not part of Endomembrane system

(a) Coordinated (b) have pigment ✗

(c) not coordinated with ER & Golgi (d) involve in Photosynthesis ✗

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cell unit of life

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8.5.3 Endomembrane System

While each of the membranous organelles is distinct in terms of its structure and function, many of these are considered together as an endomembrane system because their functions are coordinated. The endomembrane system include endoplasmic reticulum (ER), golgi complex, lysosomes and vacuoles. Since the functions of the mitochondria, chloroplast and peroxisomes are not coordinated with the above components, these are not considered as part of the endomembrane system.

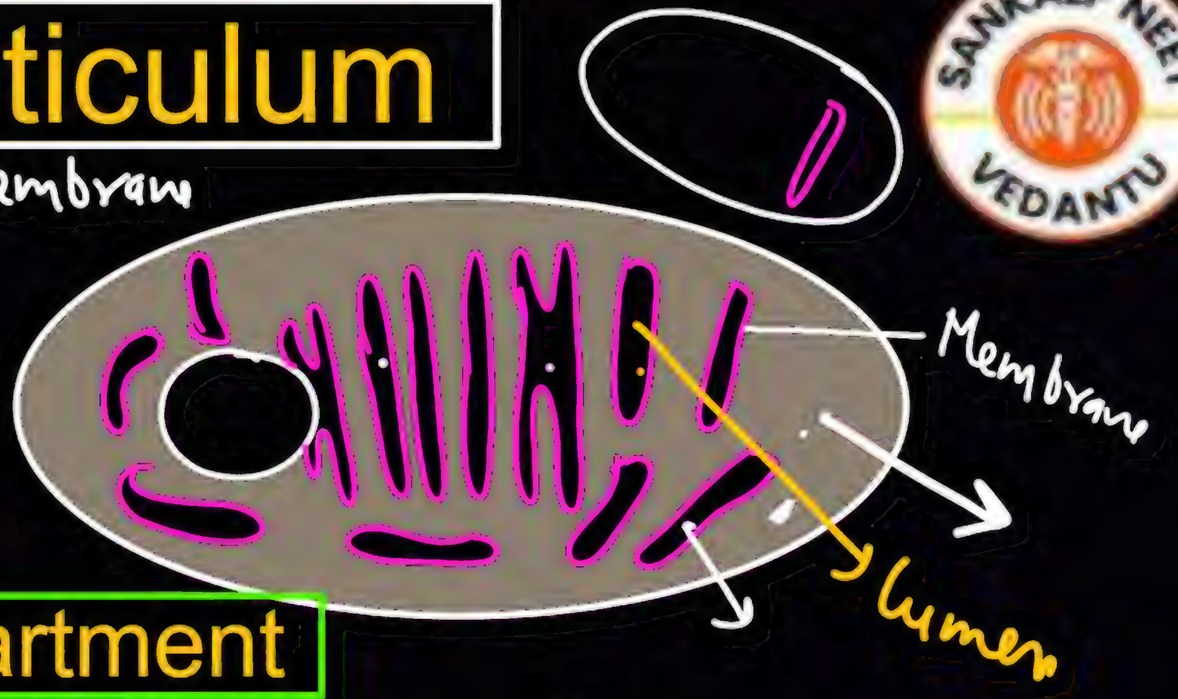
Endoplasmic Reticulum

inside → cytoplasm → Membrane

Tiny tube like structure in cytoplasm

Visible By Electron Microscope

(Endoplasmic Reticulum)



ER Divide cell into two compartment

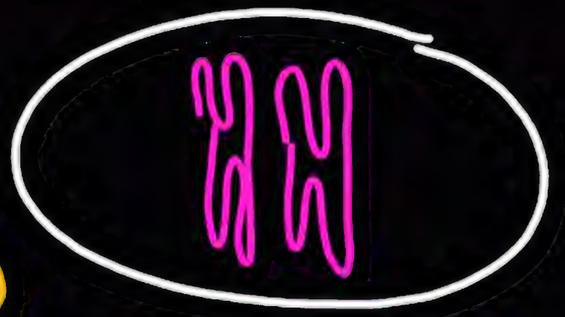
Due to ER, Cytoplasm Divided into two compartment

(a) luminal compartment (Inside lumen of ER)

(b) Cytoplasmic compartment / Extra luminal

Few Features

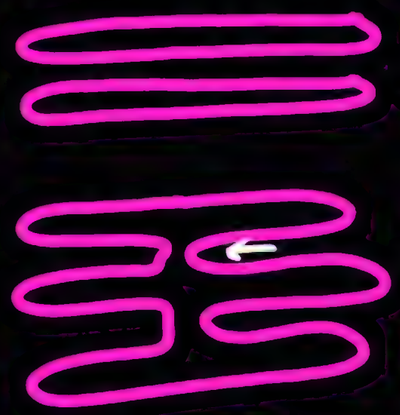
(a) large Amout of membrane in cell ⟩→



(b) Nissl granule — Present in Neuron (RER)

Sarcoplasmic Reticulum — muscle cell (SER) → Ca^{+2} Store

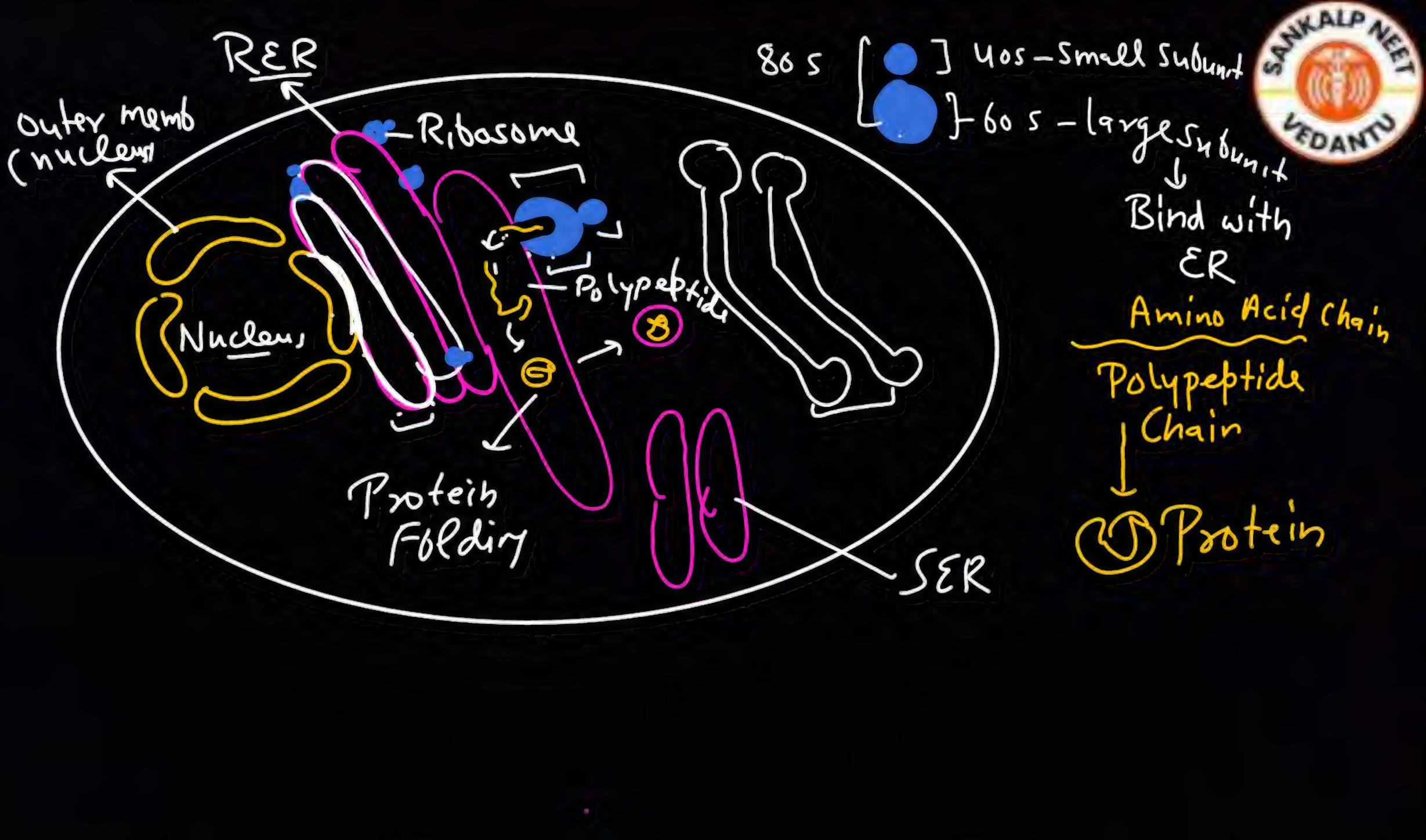
(c) Three shapes → (ER)



cisterna

vesicle

tubule


RER
Outer memb (nucleus)
Ribasome
Nucleus
Polypeptide
Protein Folding
SER
80 s
40s – Small Subunit
60 s – large Subunit
Bind with ER
Amino Acid Chain
Polypeptide Chain
Protein
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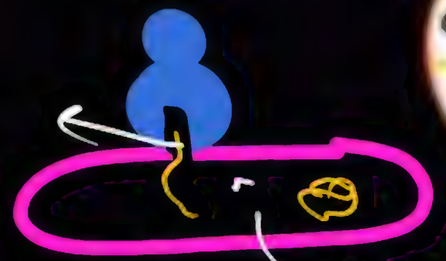
Type of ER

RER – Rough Endoplasmic Reticulum.

→ In countinuation with Nuclear Membrane

→ Ribosome attach (60 S)

→ Polypeptide chain Form → Enter into lumen of ER → Folding to become protein



RER mainly in cell – involve in protein synthesis

Ex – Glands (Protein Hormones Enzymes Form

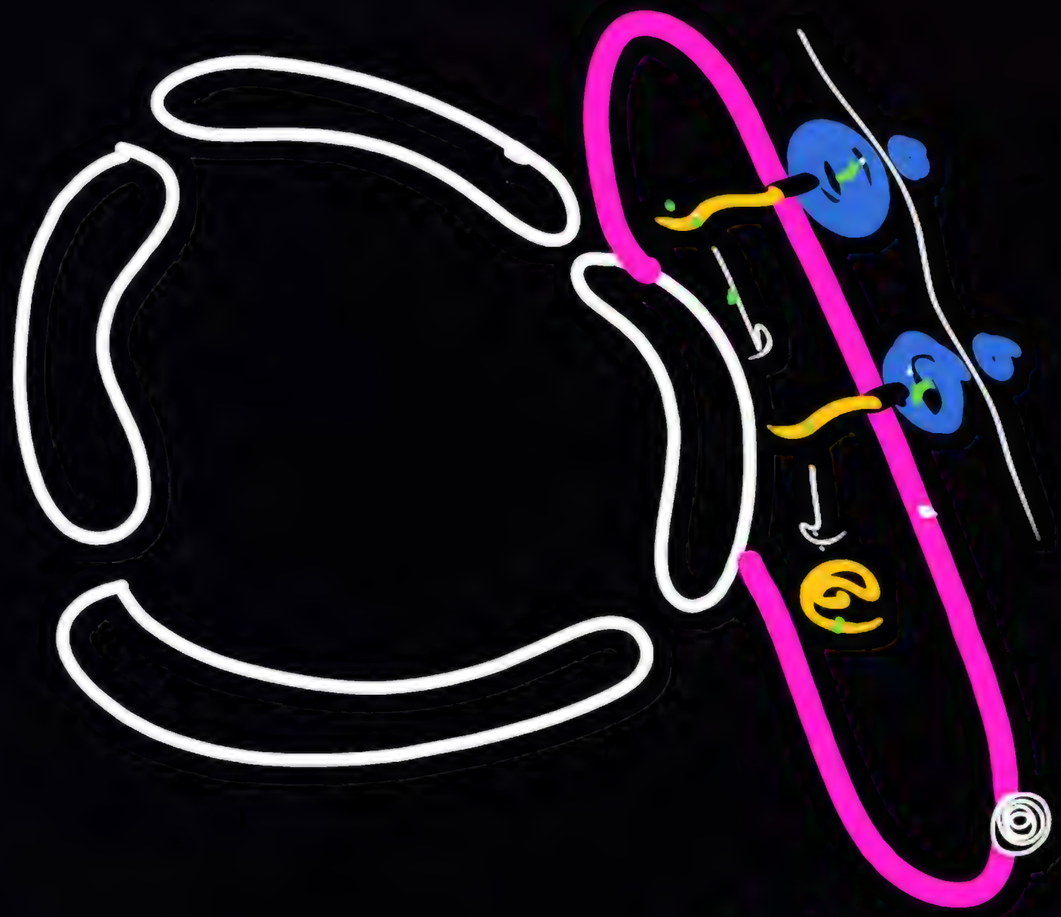
SER – Smooth Endoplasmic Reticulum → Ribosome not Attach

↳ Involve in Lipid synthesis / Steroid Hormone

Ex – Interstitial cell → In testis – testosterone (steroid)

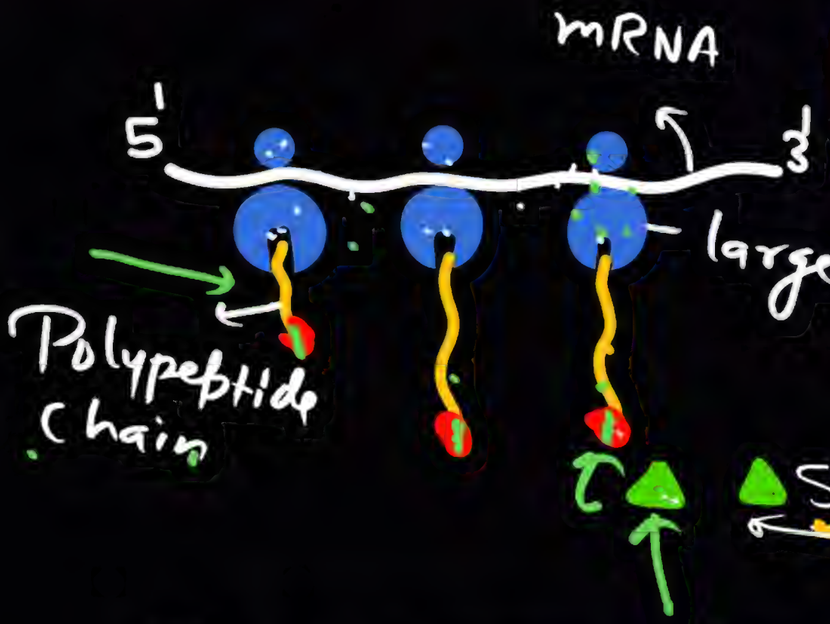
Corpus luteum – Progesterone

Extra Role → Help in detoxification



SRP
↓
Recognise
Amino Acid
Signal

Bring Ribosome
& mRNA on ER



Cytoplasmic RNA | Sc RNA

(SRP- Signal Regonition
Particle

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Q Amount of SER is high in

(a) Acinar cell in pancreas (b) α-cell in pancreas

(c) interstial cell in testis (d) medulla Region of Adrenal

Q2 Amount of RER is maximum

(a) Oxyntic cell produce HCl — HCl

(b) Gland cells produce Enzyme

(c) B-cell of pancreas

(d) Both b & c

2-d

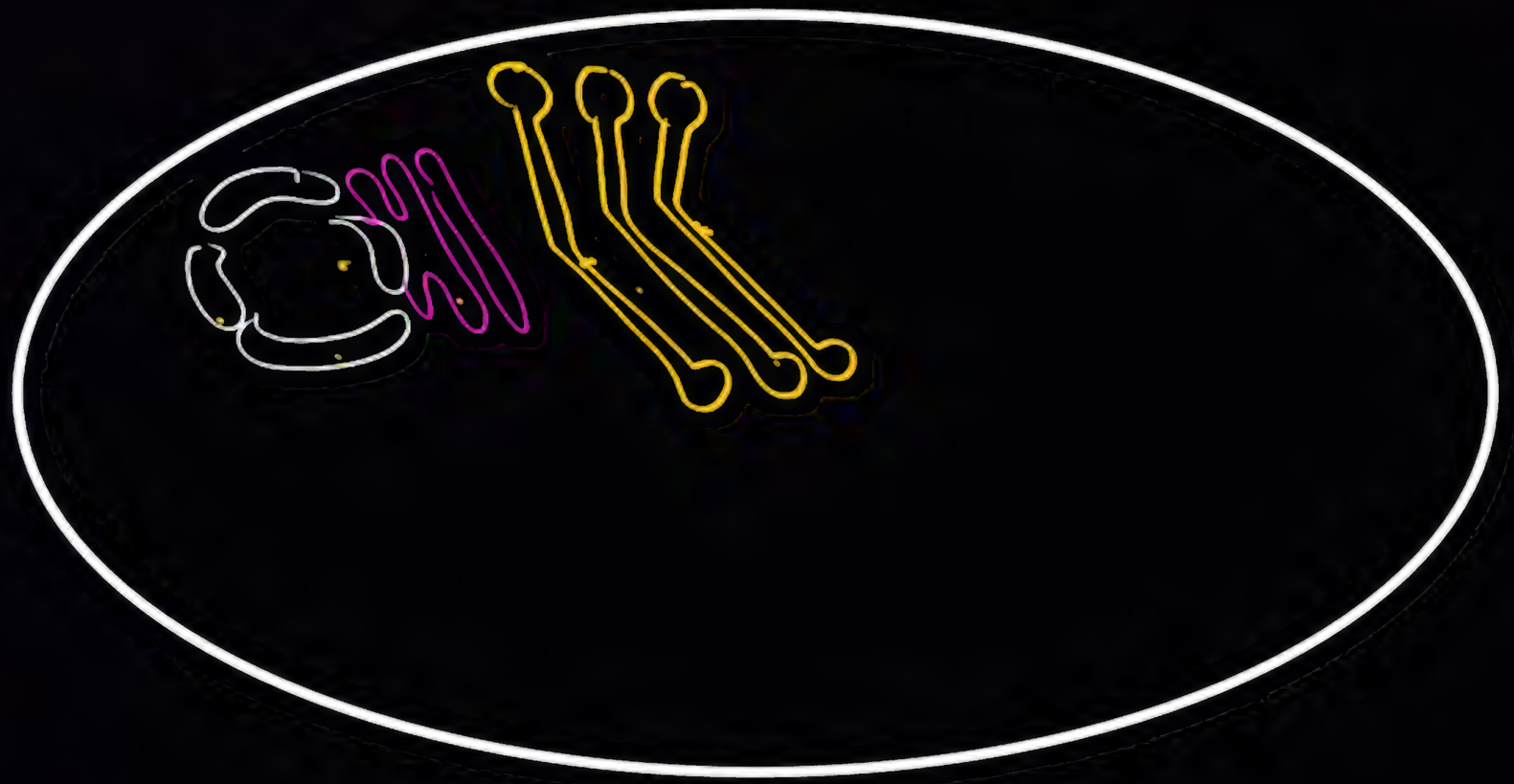
8.5.3.1 The Endoplasmic Reticulum (ER)

Electron microscopic studies of eukaryotic cells reveal the presence of a network or reticulum of tiny tubular structures scattered in the cytoplasm that is called the endoplasmic reticulum (ER) (Figure 8.5). Hence, ER divides the intracellular space into two distinct compartments, i.e., luminal (inside ER) and extra luminal (cytoplasm) compartments.

The ER often shows ribosomes attached to their outer surface. The endoplasmic reticulun bearing ribosomes on their surface is called rough endoplasmic reticulum (RER). In the absence of ribosomes they appear smooth and are called smooth endoplasmic reticulum (SER).

RER is frequently observed in the cells actively involved in protein synthesis and secretion. They are extensive and continuous with the outer membrane of the nucleus.

The smooth endoplasmic reticulum is the major site for synthesis of lipid. In animal cells lipid-like steroidal hormones are synthesised in SER.



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Golgi bodies

Camilio golgi – 1898 – Observed (stain) Flat structure, disc like Around nucleus

name Golgi Apparatus

Feature

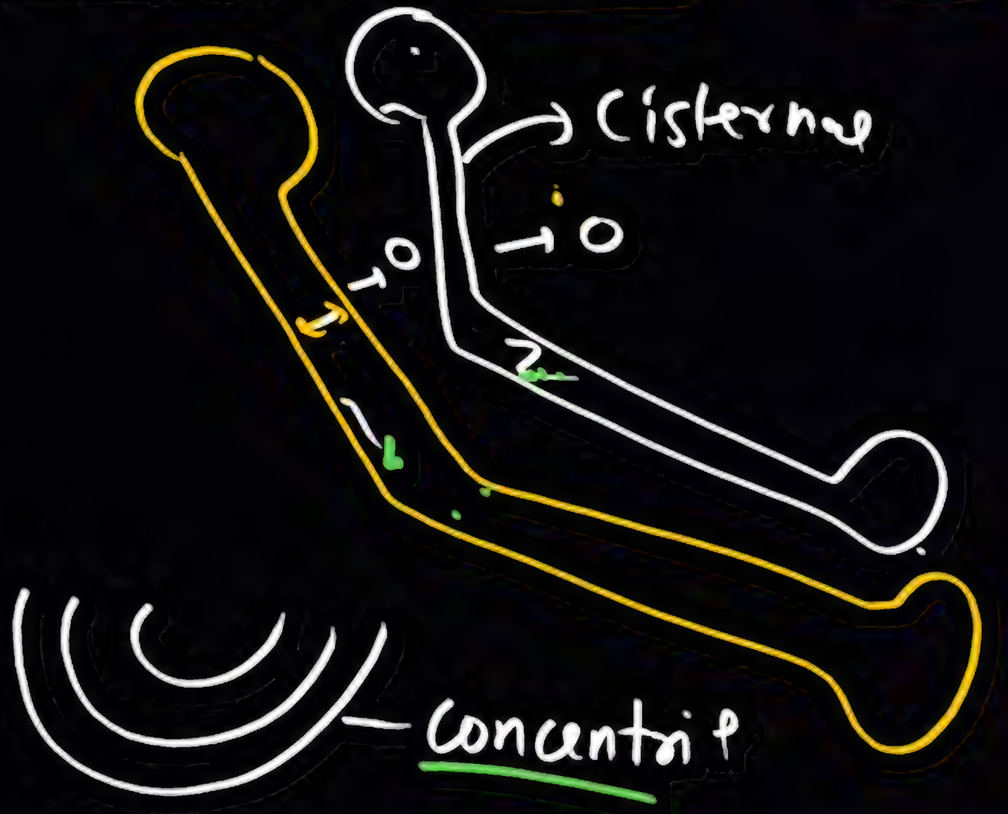
Shape → Flat, disc shape

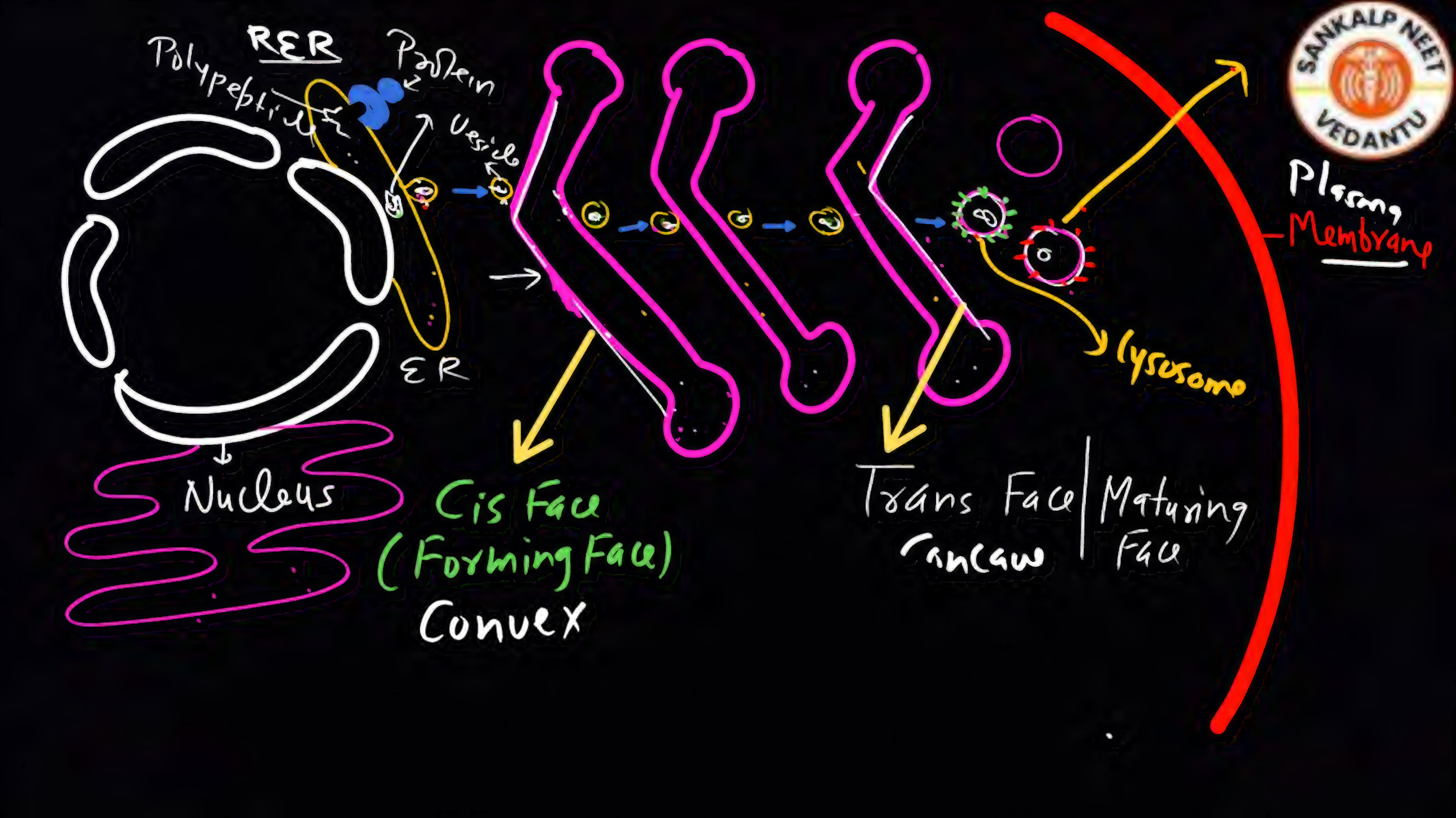
Diameter → 0.5 – 1.0 µm ✓

no. of cisternae → Variable

Concentric

location – close to nucleus




RER
Polypeptide
Protein
Vesicle
ER
Nucleus
Cis Face
(Forming Face)
Convex
Trans Face | Maturing Face
Concave
Lysosome
Plasma Membrane
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Polarity in Golgi Apparatus

— Golgi Apparatus have polarity

Cis face

- Convex
- Close to nucleus
- Vesicle Fuse From ER
- Forming Face

Trans face

- Concave
- Close to membrane
- Vesicle come out
  → Maturing Face

Direction of vesicle → ER ⟶ Cis Face Golgi ⟶ Trans face ⟶ Membrane
↘ Inside cell

Role of Golgi Apparatus

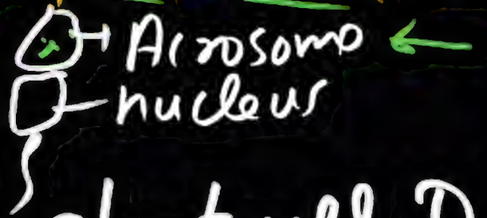
① Packaging – Protein, Enzyme inside vesicle

② Sorting of vesicle – Golgi body put tag on vesicle – whether vesicle move out of cell or remain inside cell

③ Glycoprotein and Glycolipid → Golgi body modify protein & lipid By Adding Sugar

④ lysosome Formation – Intra cellular vesicle is lysosome

Extra role → ① Sperm head have Acrosome derive from golgi body



② In plant cell, Division occur, Middle lamella deposited By Golgi body

8.5.3.2 *Golgi apparatus*

Camillo Golgi (1898) first observed densely stained reticular structures near the nucleus. These were later named Golgi bodies after him. They consist of many flat, disc-shaped sacs or cisternae of 0.5µm to 1.0µm diameter (Figure 8.6). These are stacked parallel to each other. Varied number of cisternae are present in a Golgi complex. The Golgi cisternae are concentrically arranged near the nucleus with distinct convex *cis* or the forming

face and concave *trans* or the maturing face. The *cis* and the *trans* faces of the organelle are entirely different, but interconnected.

The golgi apparatus principally performs the function of packaging materials, to be delivered either to the intra-cellular targets or secreted outside the cell. Materials to be packaged in the form of vesicles from the ER fuse with the *cis* face of the golgi apparatus and move towards the maturing face. This explains why the golgi apparatus remains in close association with the endoplasmic reticulum. A number of proteins synthesised by ribosomes on the endoplasmic reticulum are modified in the cisternae of the golgi apparatus before they are released from its *trans* face. Golgi apparatus is the important site of formation of glycoproteins and glycolipids.

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Lysosomes

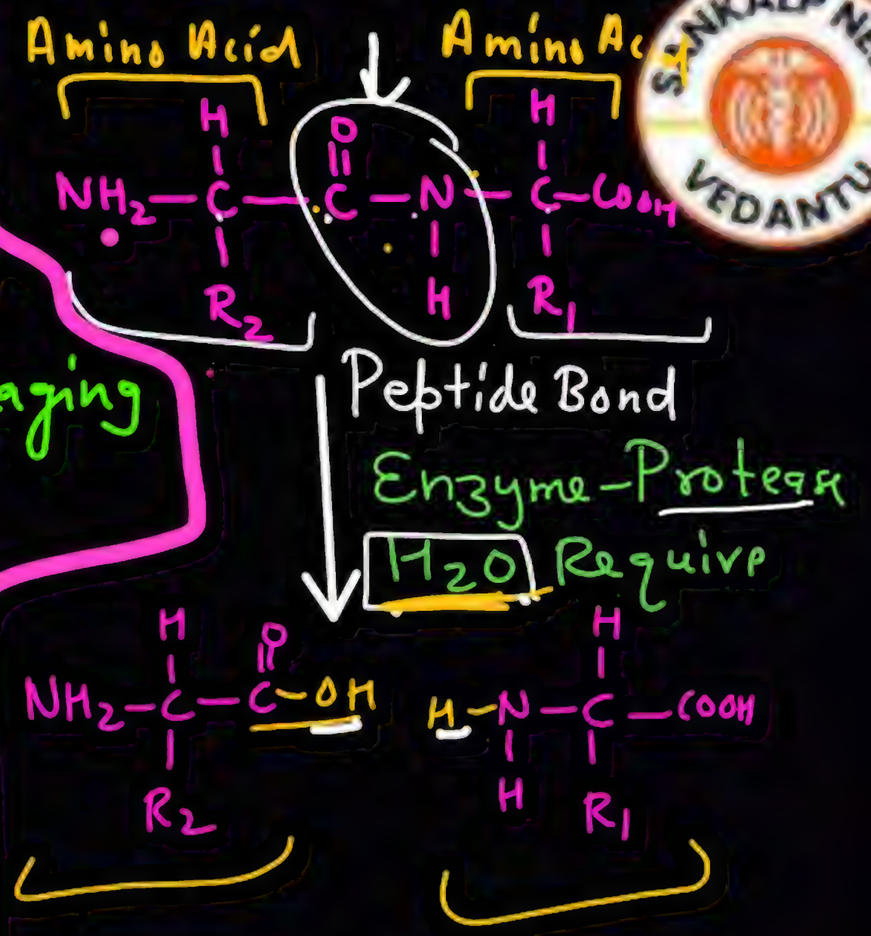
Structure → Vesicle type membrane Bound Structure

derive From → Golgi Apparatus During Final packaging

Enzyme present →
- Hydrolytic Enzymes | Hydrolases
- Act at Acidic PH
- Require H_2O to Break Bond ✓

Example of Hydrolases → Carbohydratases
→ Protease
→ Lipase → Nucleases

PH → Hydrolytic Enzyme Act as Acidic PH



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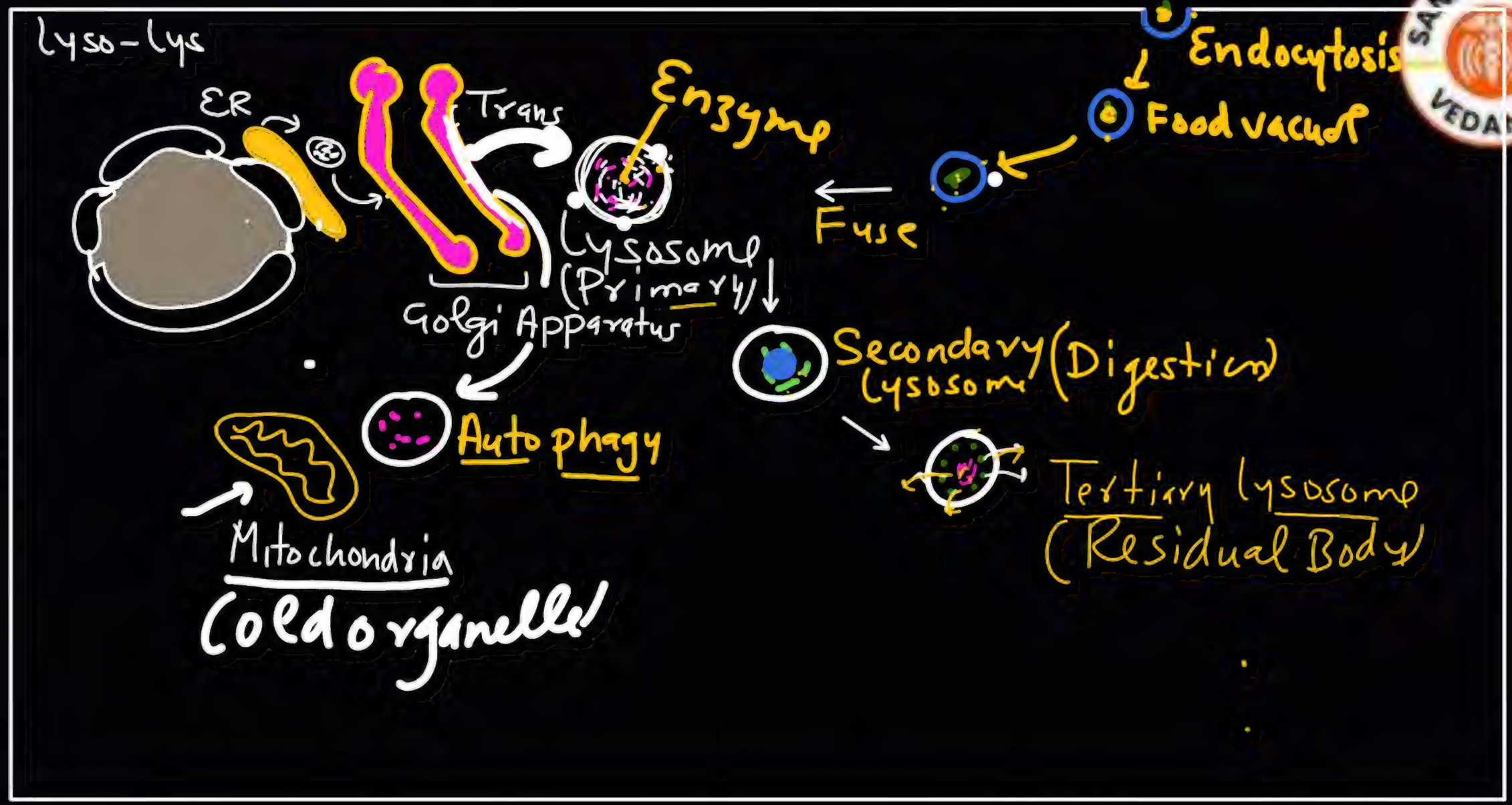

Lyso-lys
ER
Trans
Golgi Apparatus
Enzyme
Lysosome (Primary)
Endocytosis
Food vacuole
Fuse
Secondary (Digestion)
Lysosome
Tertiary lysosome
(Residual Body)
Autophagy
Mitochondria
Cell organelle!

Type of lysosomes

① Primary ⟶ Derive From Golgi Apparatus, Enzymes Present
② Secondary → Digestion occuring
③ tertiary → Digestion completed in Lysosome | Residual Body
④ Autophagy — Digest old organelle

Role of lysosomes — ① Intracellular digestion of Food particle
② Recycling of old organelle

note - lysosome have many type in Morphology - They show polymorphism

note - Mitochondria have Enzymes number Greater than Lysosome

8.5.3.3 *Lysosomes*

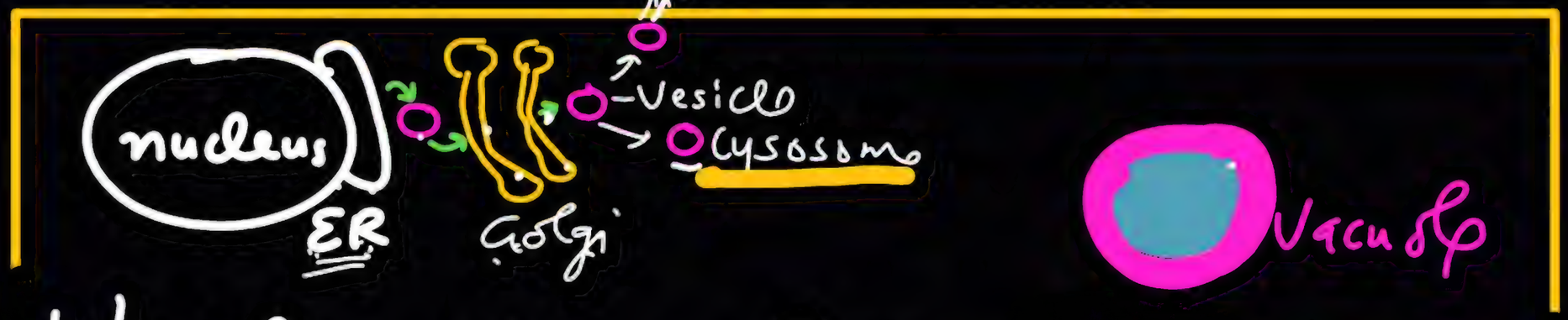
These are membrane bound vesicular structures formed by the process of packaging in the golgi apparatus. The isolated lysosomal vesicles have been found to be very rich in almost all types of hydrolytic enzymes (hydrolases - lipases, proteases carbohydrases) optimally active at the acidic pH. These enzymes are capable of digesting carbohydrates, proteins, lipids and nucleic acids

nucleases

Vesicle and Vacuole

Q Lysosome are active at

(a) acidic PH (b) basic PH (c) intracellular ✓ (d) a RC



Vesicle - membrane Bound, small, Transport, not proper organelle

Vacuole - membrane Bound, large, Store substance not useful For cell, organelle consider]

Vacuoles

→ Membrane Bound space Found in Cytoplasm

→ Store - water, Sap (water + ion + Sugar), ions and other material

→ Many Substance not Require By cell

Type of vacuole

(a) Sap vacuole
(b) Contractile vacuole
(c) Food vacuole

} Found in Eukaryotic cells

(d) Gas vacuole - It is not proper vacuole, it is inclusion Body
Found in prokaryotic

① Sap vacuole

Sap → water + ions, sugar

Present in – Plant cells (upto 90% volume occupy)

Membrane – Like other membrane
But have special Role ✓
to pump ions inside vacuole

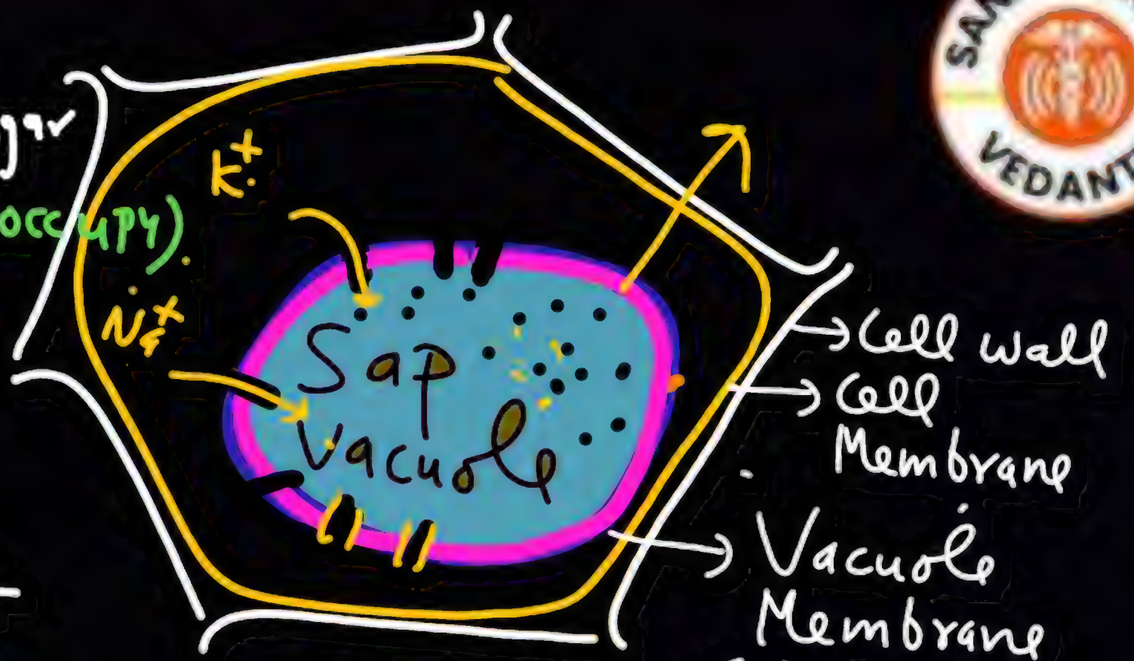
name of membrane = Tonoplast

– with the help of pump → ions move
Against conc. gradient

→ Conc. of ions are Greater in vacuole

→ Water move From cytoplasm to vacuole

Function – maintain turgidity



Plant cell (Tono plast)

Tono – Tonicity – Salt conc.

[Vacuole – more ion – Hypertonic
Cytoplasm – less ion → Hypotonic

② Contractile vacuole →

Size can change

Fresh water – Amoeba, Euglena (cytoplasm – Solute present → Hypertonic)

Euglena, Amoeba

Problem – outside Fresh water (Hypotonic)

[– Water Enter into cell]

Role – Remove Excess of water – Excretion

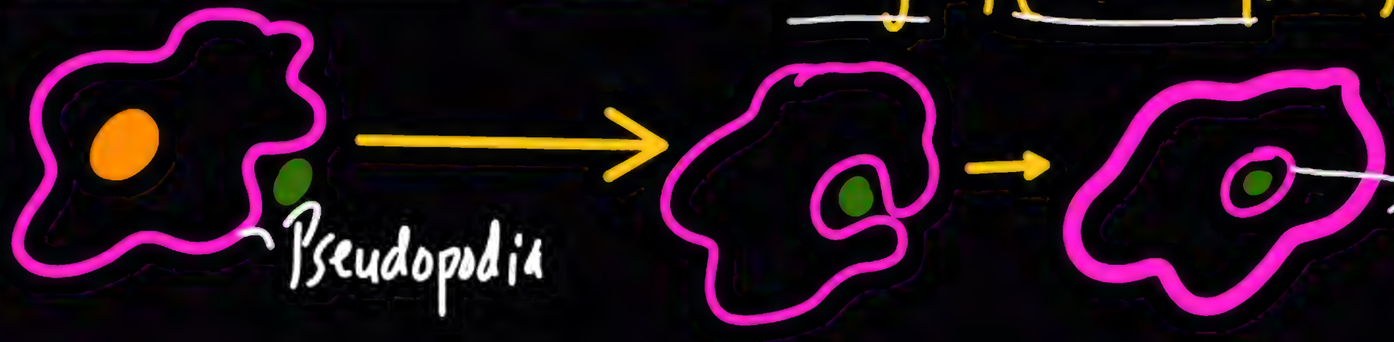
– Osmoregulation

Fresh water

→ hypertonic

Food vacuole – Amoeba – Engulf (Endocytosis) Food material ✓

③



8.5.3.4 *Vacuoles*

The vacuole is the membrane-bound space found in the cytoplasm. It contains water, sap, excretory product and other materials not useful for the cell. The vacuole is bound by a single membrane called tonoplast. In plant cells the vacuoles can occupy up to 90 per cent of the volume of the cell.

In plants, the tonoplast facilitates the transport of a number of ions and other materials against concentration gradients into the vacuole, hence their concentration is significantly higher in the vacuole than in the cytoplasm.

In *Amoeba* the **contractile vacuole** is important for osmoregulation and excretion. In many cells, as in protists, **food vacuoles** are formed by engulfing the food particles.

Ribosome

Discovered BY – 1953 – Palade observed granular Structure in cytoplasm By Electron Microscope

visible in – Electron microscope

membrane – without Membrane organelle, Present in all type of cell (Prokaryotic cell as well as Eukaryotic cell)

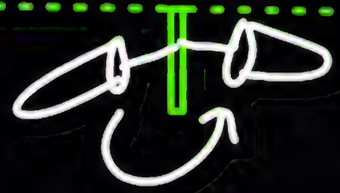
I Type – on the Basis of size
(a) 70 S (b) 80 S

II on the Basis of location
(a) Cytoplasmic Ribosome → 70 S – Bacteria Cytoplasm
→ 80 S → Eukaryotic cell Cytoplasm
(b) Organelle (Mitochondria, Plastids → 70 S

Each type of Ribosome → two Subunit → (a) large (b) Small

Svedberg's constant or Sedimentation cofficient

Indirect method to measure size & density of Ribosome



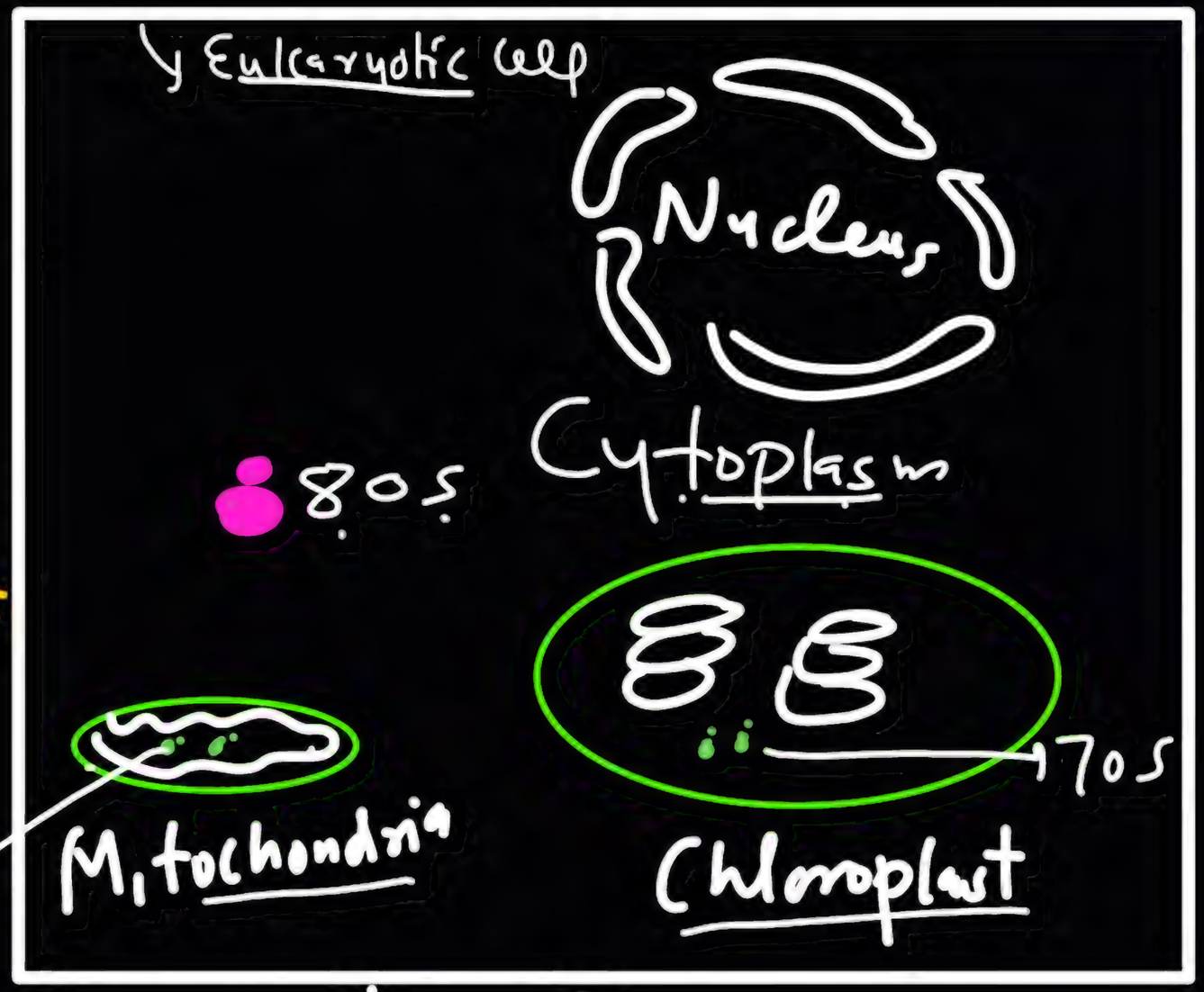
Prokaryotic cell

Ribosome = 70 s
(Cytoplasm)

Q 70 s Ribosome Absent in Eukaryotic
(a) Amoeba (b) Yeast
(c) RBC (d) all

(c) ↓ X

Eukaryotic cell



Eukaryotic cell

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(a) 70 s Ribosome — large Subunit - 50 s
Small Subunit = 30 s

30 s — Small

50 s — large

16 s rRNA + Protein

23 s rRNA + Protein

and 5 s

note - Small Subunit one type of rRNA which is 16 s

(b) 80 s Ribosome

40 s — Small Subunit

60 s — large Subunit

18 s rRNA + Protein

total 80 type protein

rRNA + Protein

5 s
5.8 s
28 s

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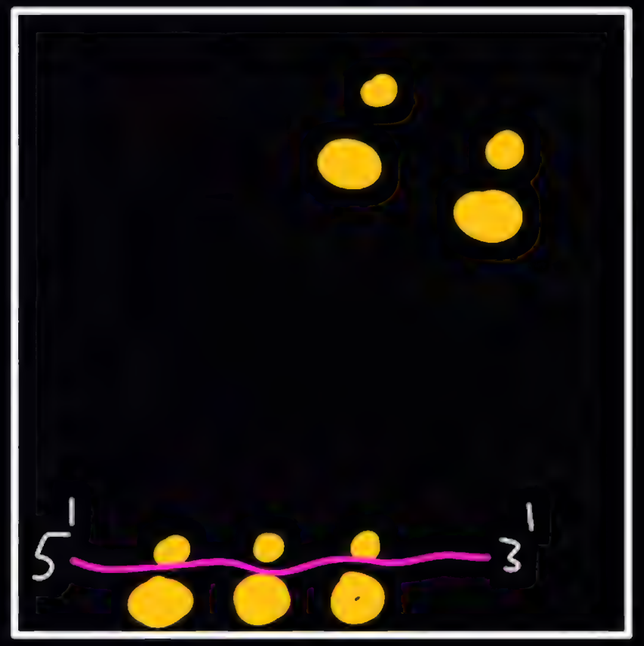

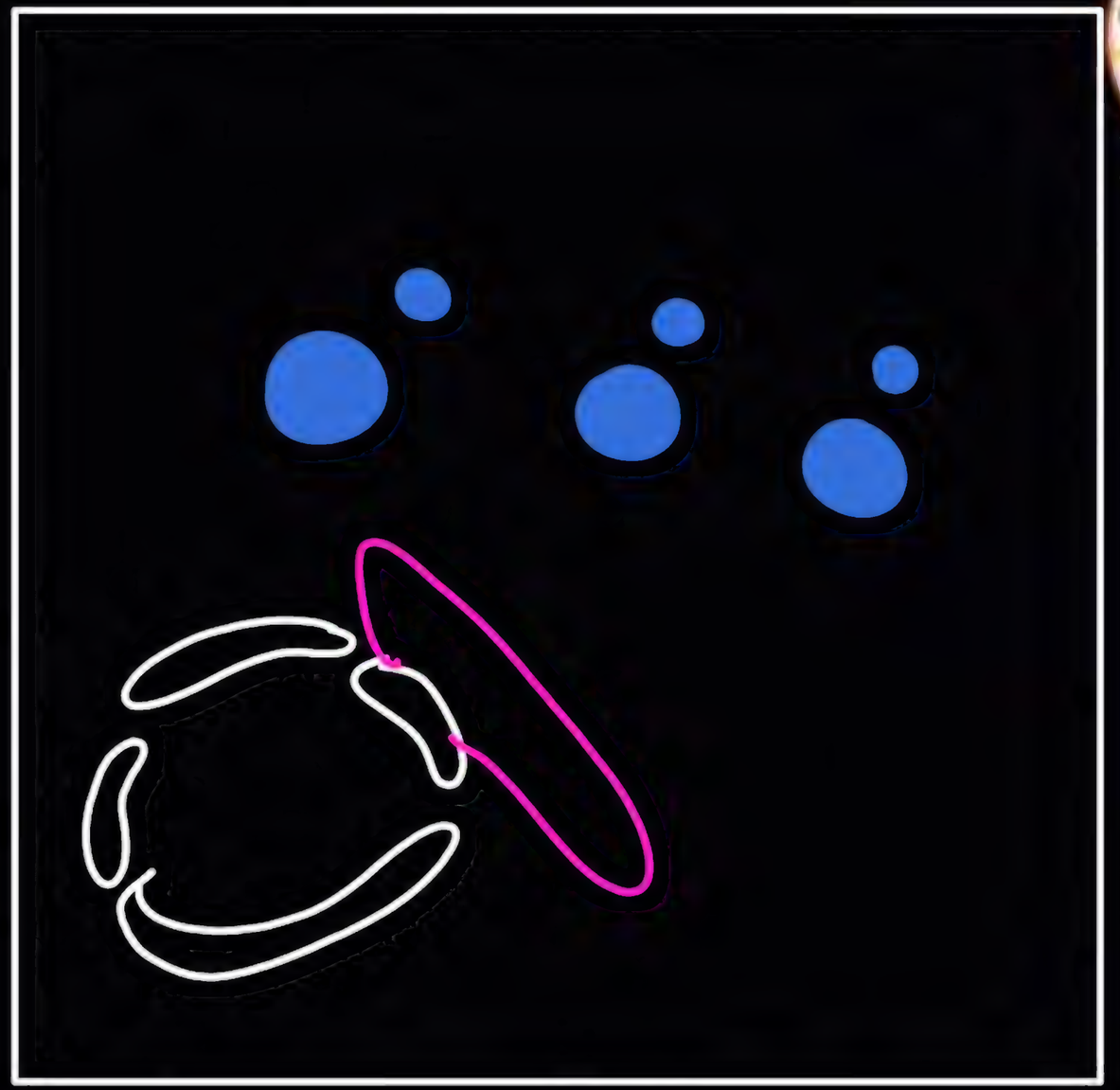

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8.5.6 Ribosomes

Ribosomes are the granular structures first observed under the electron microscope as dense particles by George Palade (1953). They are composed of ribonucleic acid (RNA) and proteins and are not surrounded by any membrane.

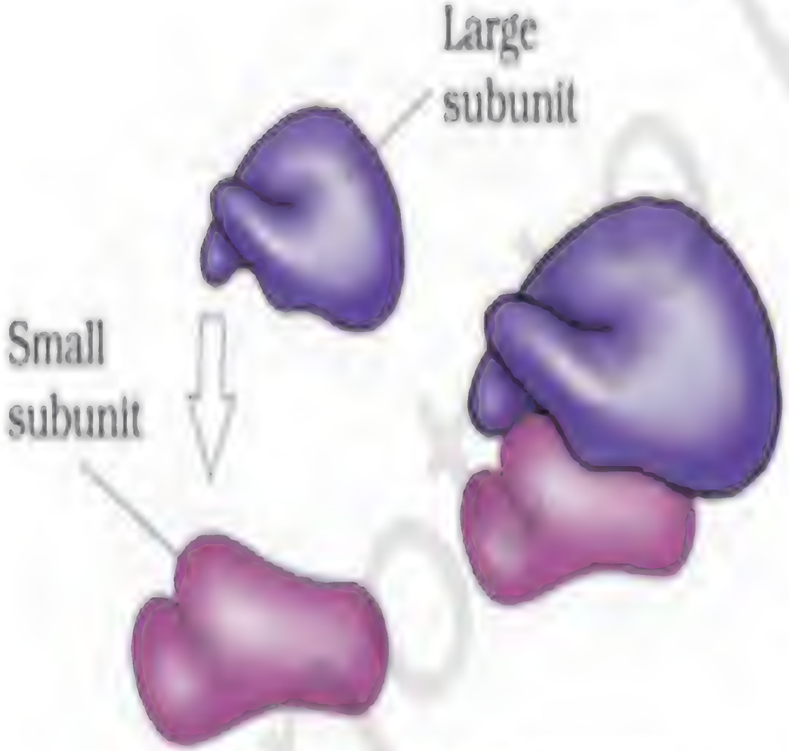

Figure 8.9 Ribosome

The eukaryotic ribosomes are 80S while the prokaryotic ribosomes are 70S. Each ribosome has two subunits, larger and smaller subunits (Fig 8.9). The two subunits of 80S ribosomes are 60S and 40S while that of 70S ribosomes are 50S and 30S. Here 'S' (Svedberg's Unit) stands for the sedimentation coefficient; it is indirectly a measure of density and size. Both 70S and 80S ribosomes are composed of two subunits.

- rRNA in prokaryotes synthesise at

- rRNA in Eukaryotes synthesise at

Q Which not present in E. coli

(a) 23 S rRNA (b) 5 S rRNA

(c) 28 S rRNA (d) 16 S rRNA

DOPA-04

Q1 16s rRNA present in
(a) Mitochondria (b) Plastid (c) E. coli (d) all

Q2 Absent in Eulcaryotic cell
(a) Cillia (b) Mesosome (c) Flagella (d) 80s ribosome

Q3 Contractile vacuole present in
(a) Euglena (b) Amoeba (c) Macrophage (d) Both a & b

Q4 Food vacuole not present in
(a) Amoeba (b) all protist (c) some protist (d) Macrophage

Q5 Not present in lysosome
(a) Enzyme (b) Acid (c) Hydrolase (d) Basic Enzyme

Q6 23 S rRNA present in

(a) 50 S (b) 40 S (c) 30 S (d) 60 S

Q7 Svedberg's constant is measure of

(a) Size (b) density (c) Colour (d) both a & b

Q8 Without Membrane in nostoc

(a) 80 S ribosome (b) 70 S ribosome (c) Nucleolus (d) all

Q9 70 S ribosome in Plant cell like mesophyll in

(a) Cytoplasm (b) Mitochondria (c) Plastid (d) Both b & c

Q10 Main function of Contractile vacuole

(a) Osmoregulation (b) Excretion (c) Both a & b (d) Present in Marine organism

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cell unit of life

lecture – 09

Botany

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8.5.6 Ribosomes

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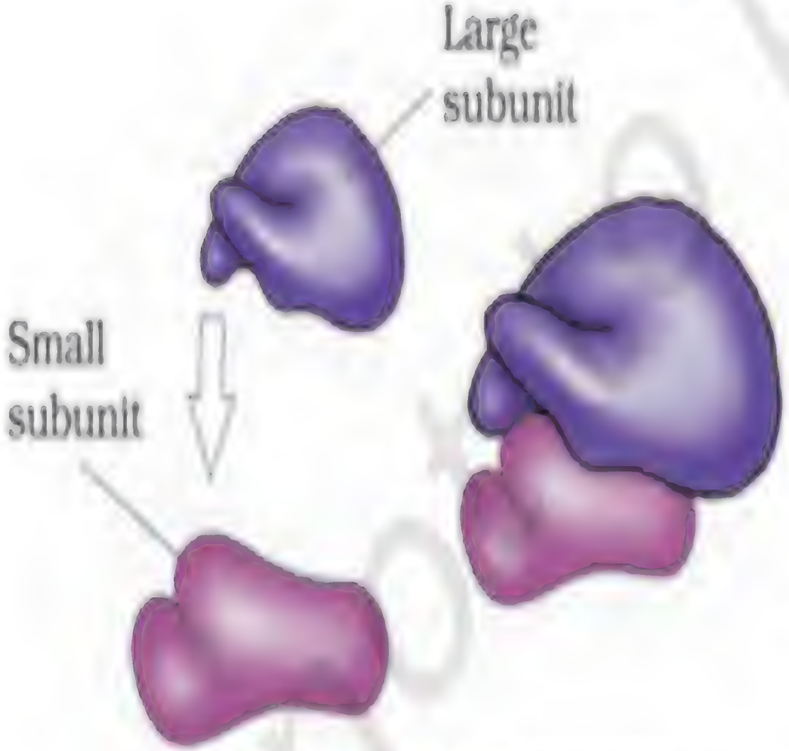

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- rRNA in Eukaryotes synthesise at

Q Which not present in E. coli

(a) 23 S rRNA (b) 5 S rRNA

(c) 28 S rRNA (d) 16 S rRNA

DOPA-04

70S

Q1 16S rRNA present in
(a) Mitochondria (b) Plastid (c) E. coli (d) all
cytop

Q2 Absent in Eulcaryotic cell
(a) Cillia (b) Mesosome (c) Flagella (d) 80 S ribosome

Q3 Contractile vacuole present in
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(a) Enzyme (b) Acid (c) Hydrolase (d) Basic Enzyme

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(a) 50 S (b) 40 S (c) 30 S (d) 60 S

Q7 Svedberg's constant is measure of

(a) Size (b) density (c) Colour (d) both a & b

Q8 Without Membrane in nostoc — Bacterium

(a) 80 S ribosome (b) 70 S ribosome (c) Nucleolus (d) all

Q9 70 S ribosome in Plant cell like mesophyll in

(a) Cytoplasm (b) Mitochondria (c) Plastid (d) Both b & c (d)

Q10 Main function of Contractile vacuole

(a) Osmoregulation (b) Excretion (c) Both a & b (d) Present in Marine organism

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Mitochondria

Mitochondrion – Singular
Mitochondria – Plural

Shape → Can be variable, mostly shape is Cylindrical / Sausage type

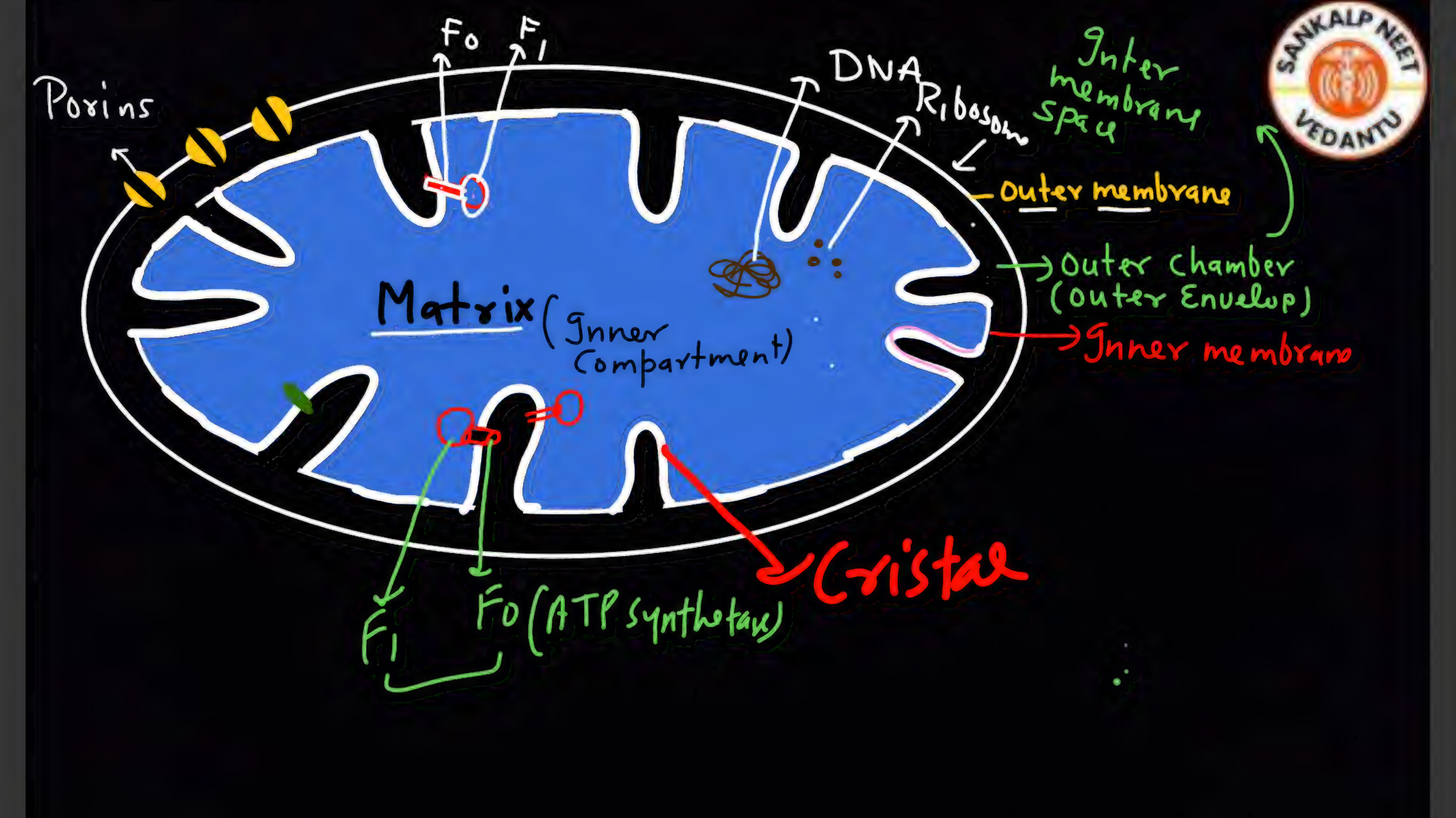
Size →

Size Approximately Like Bacteria Cell

number → More in those cells, which Are Physiologically Active (Ex – Muscles)

visible when → It is stained properly (Janus green – stain)

(Although size large)


Fo
F1
DNA
Ribosome
Inter membrane space
Porins
Outer membrane
Outer chamber (Outer Envelop)
Matrix (Inner Compartment)
Inner membrane
F1
Fo (ATP synthetase)
Cristae

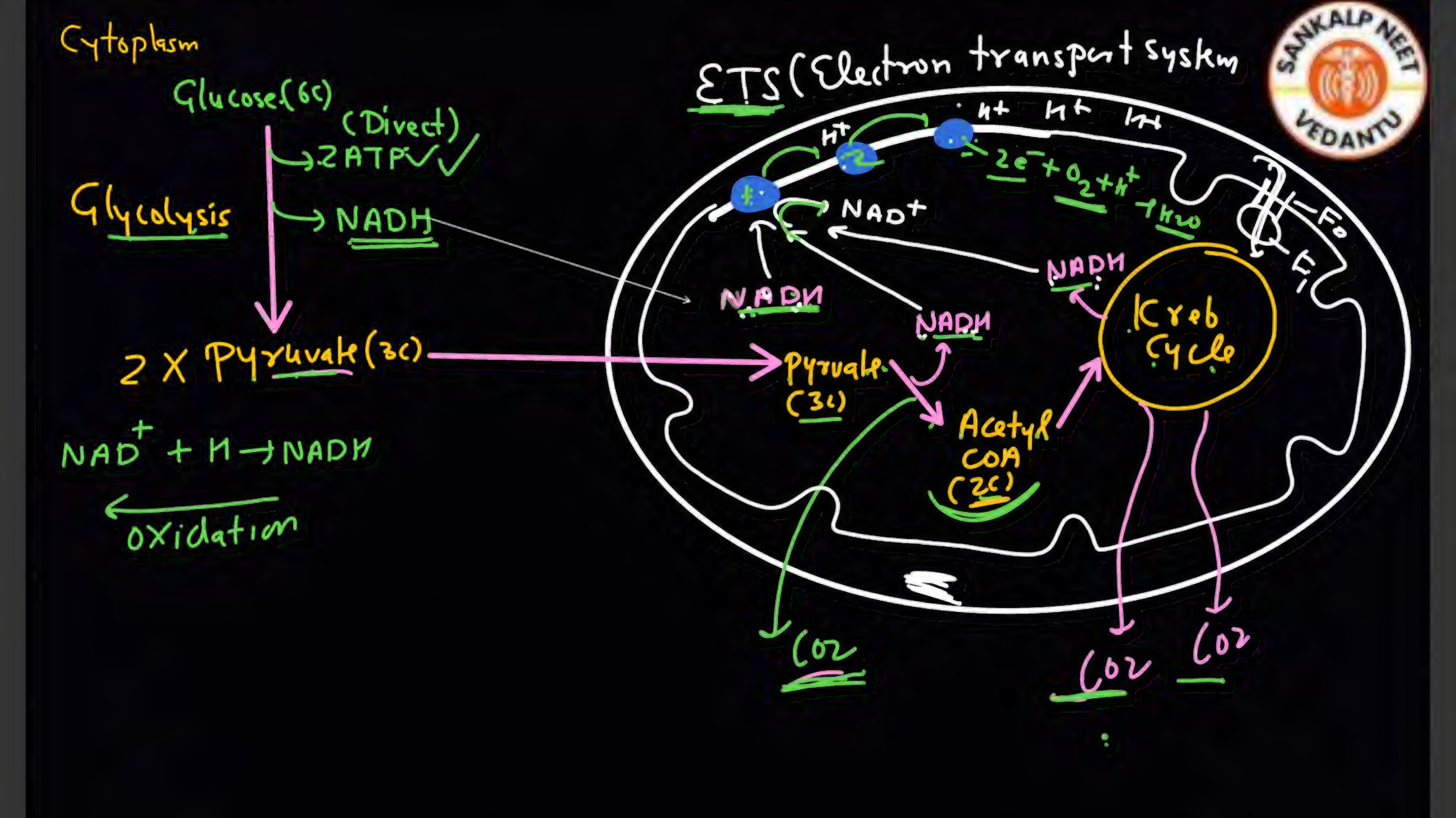
Structure

Outer membrane
- made up of lipid Bilayer, Seperate mitochondria From Cytoplasm
- Different prokins (Example – Porins)

Inner membrane
- Lipid Bilayer, Seperate Aqueous Enviroment of mitochondria into two chamber — (a) Outer compartment (b) Inner compartment
- Show infolding — to inc. Surface Area
- Inner membrane – Enzyme of ETS (Electron transport system)
- → F_0–F_1 Particle present on Inner Membrane

Intermembrane space
- → outer compartment, H^+ accumulate, move back into matrix → ATP Form

Matrix
- → Pyruvate to Acetyl CoA → than Enter Kreb cycle ((inlc Rxn)
- → DNA present (Single, Circular), Ribosome present [Energy From-ATP, Protein Synthesis]


Cytoplasm
Glucose (6C)
(Direct)
2 ATP
Glycolysis
NADH
2 X Pyruvate (3C)
NAD+ + H → NADH
Oxidation
ETS (Electron transport system
H+
2e⁻ + O2 + H+
NAD+
NADH
NADH
NADH
Pyruvate (3C)
Acetyl CoA (2C)
Krebs Cycle
Fo
F1
CO2
CO2
CO2
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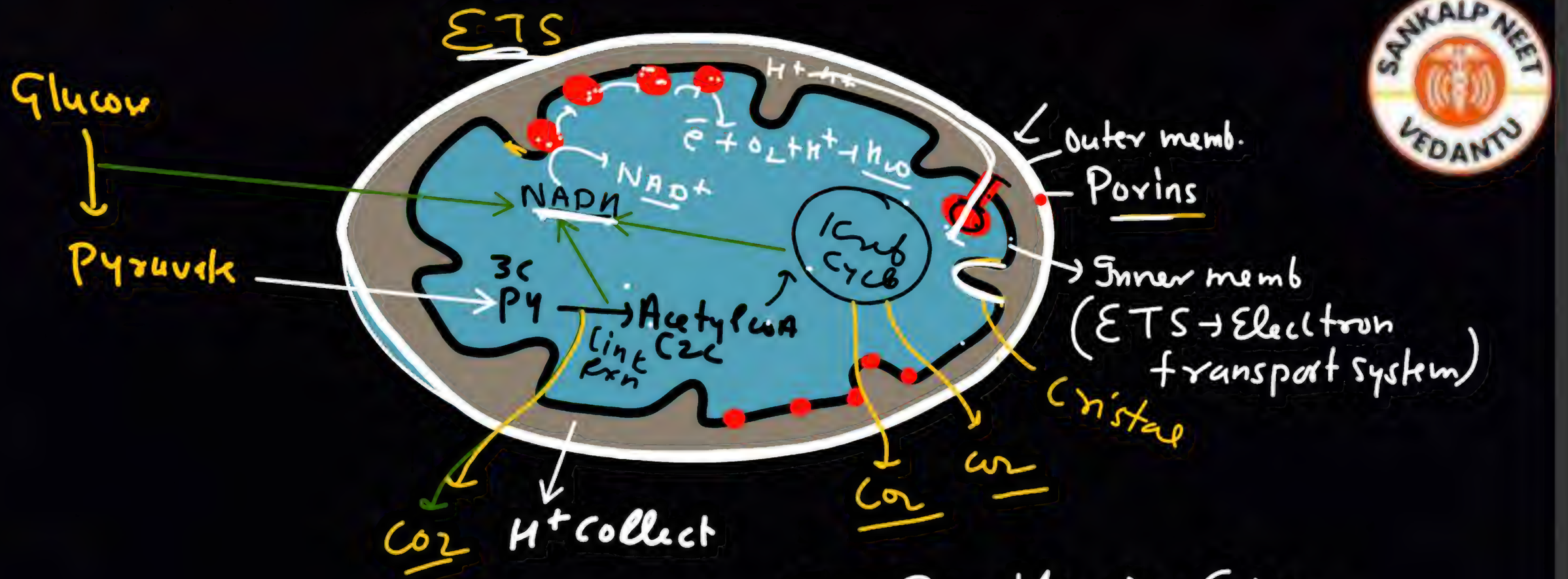


ATP, H_2O, CO_2

Use – O_2

* Mitochondria → For Aerobic Respiration (O_2 use)
* Mitochondria → produce CO_2 (come out)
  Use → O_2 → to produce H_2O
* ETS → present on inner membrane of Mitochondria
  Oxidise NADH and move $\bar{e}$ of NADH
* H^+ collect in intermembrane space → move through F_0-F_1 particle ATP Form (Cellular Energy)
* Matrix also have - DNA (circular, ds)
  Ribosome - 70 s
* Mitochondria divide By Fission

8.5.4 Mitochondria

Mitochondria (sing.: mitochondrion), unless specifically stained, are not easily visible under the microscope. The number of mitochondria per cell is variable depending on the physiological activity of the cells. In terms of shape and size also, considerable degree of variability is observed. Typically it is sausage-shaped or cylindrical having a diameter of 0.2-1.0μm (average 0.5μm) and length 1.0-4.1μm. Each mitochondrion is a double

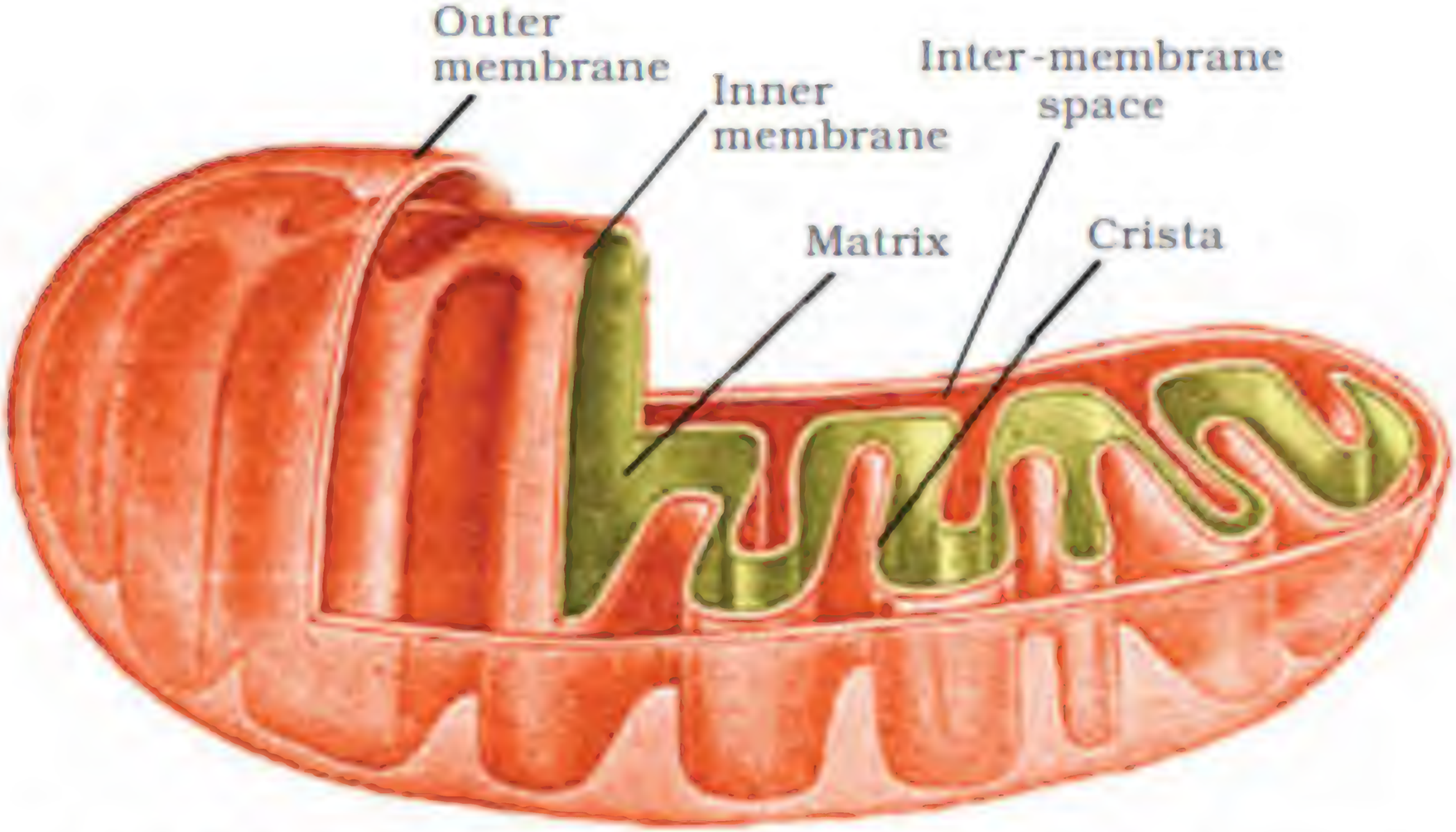


Figure 8.7 Structure of mitochondrion (Longitudinal section)

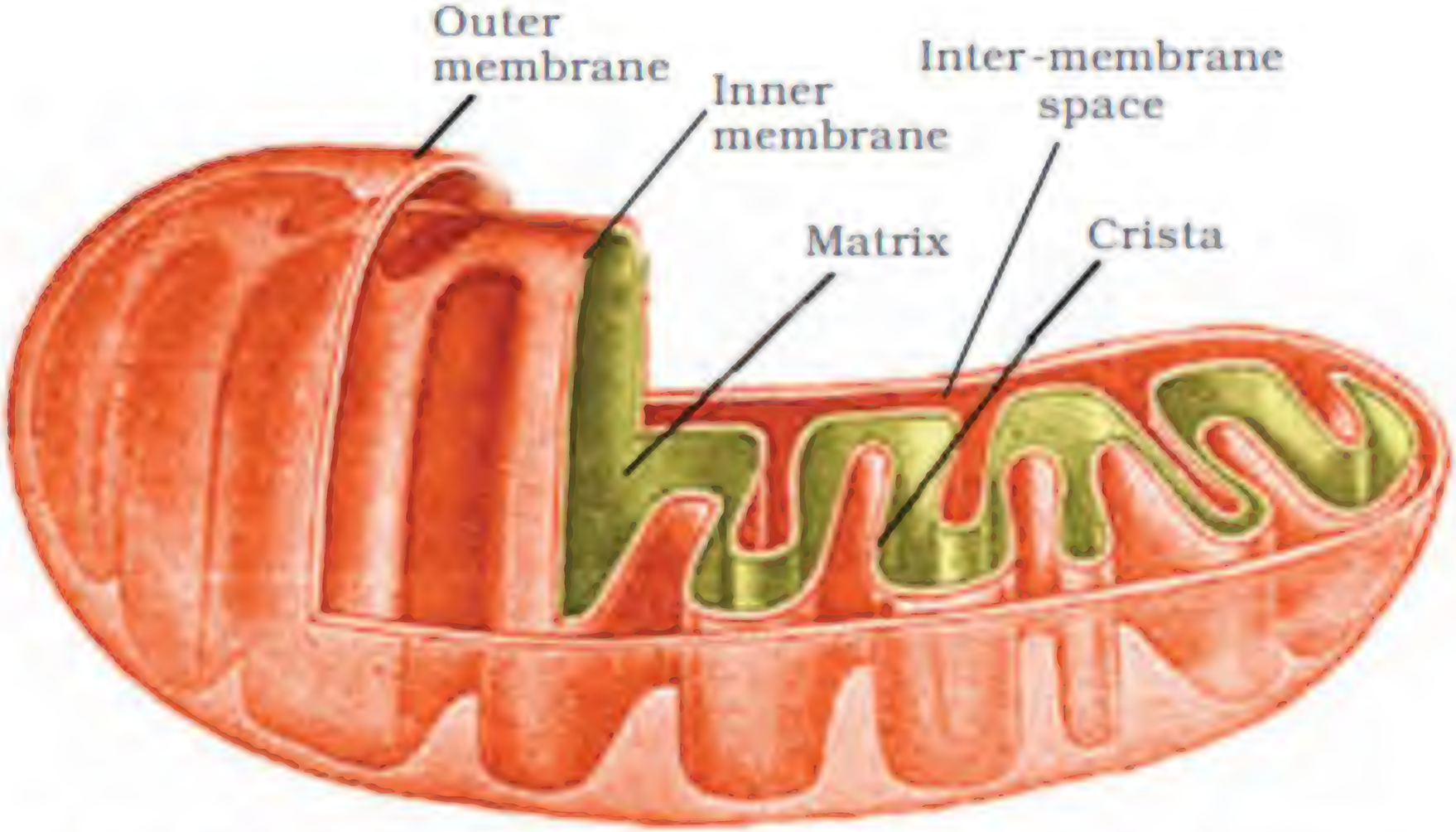
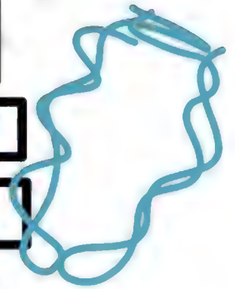


Figure 8.7 Structure of mitochondrion (Longitudinal section)

membrane-bound structure with the outer membrane and the inner membrane dividing its lumen distinctly into two aqueous compartments, i.e., the outer compartment and the inner compartment. The inner compartment is filled with a dense homogeneous substance called the **matrix**. The outer membrane forms the continuous limiting boundary of the organelle. The inner membrane forms a number of infoldings called the cristae (sing.: crista) towards the matrix (Figure 8.7). The cristae increase the surface area. The two membranes have their own specific enzymes associated with the mitochondrial function. Mitochondria are the sites of aerobic respiration. They produce cellular energy in the form of ATP, hence they are called 'power houses' of the cell. The matrix also possesses single circular DNA molecule, a few RNA molecules, ribosomes (70S) and the components required for the synthesis of proteins. The mitochondria divide by fission.



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cell unit of life

lecture – 10

Botany

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Topic

Plastids ✓

Cytoskeletal Elements

Pigments

def - Chemical compound → Trap wavelength of light

Example → Chlorophyll, Carotenoids

Chlorophyll (Green colour)

Carotenoids: ① Carotene → Red, orange → Type - Lycopene

② Xanthophyll → Ex - Fucoxanthin - Brown ✓

Lutein - Yellow ✓

Soluble in organic solvent | Fat soluble

Chlorophyll a - main pigment - All plants ✓

Chl b → Bryophytes, Pteridophytes, Gymnosperm, Angiosperm - Green Algae

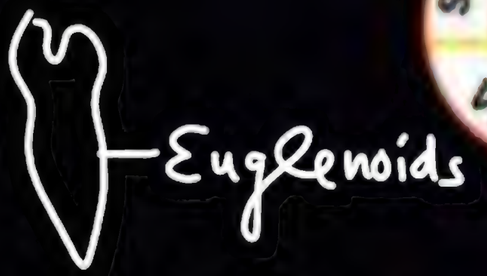
Chl c → Brown Algae

Chl d → Red Algae

Plastids

Present in → In all plant cell and Euglenoids

visible in – Colour present (Pigment present)
large size present →



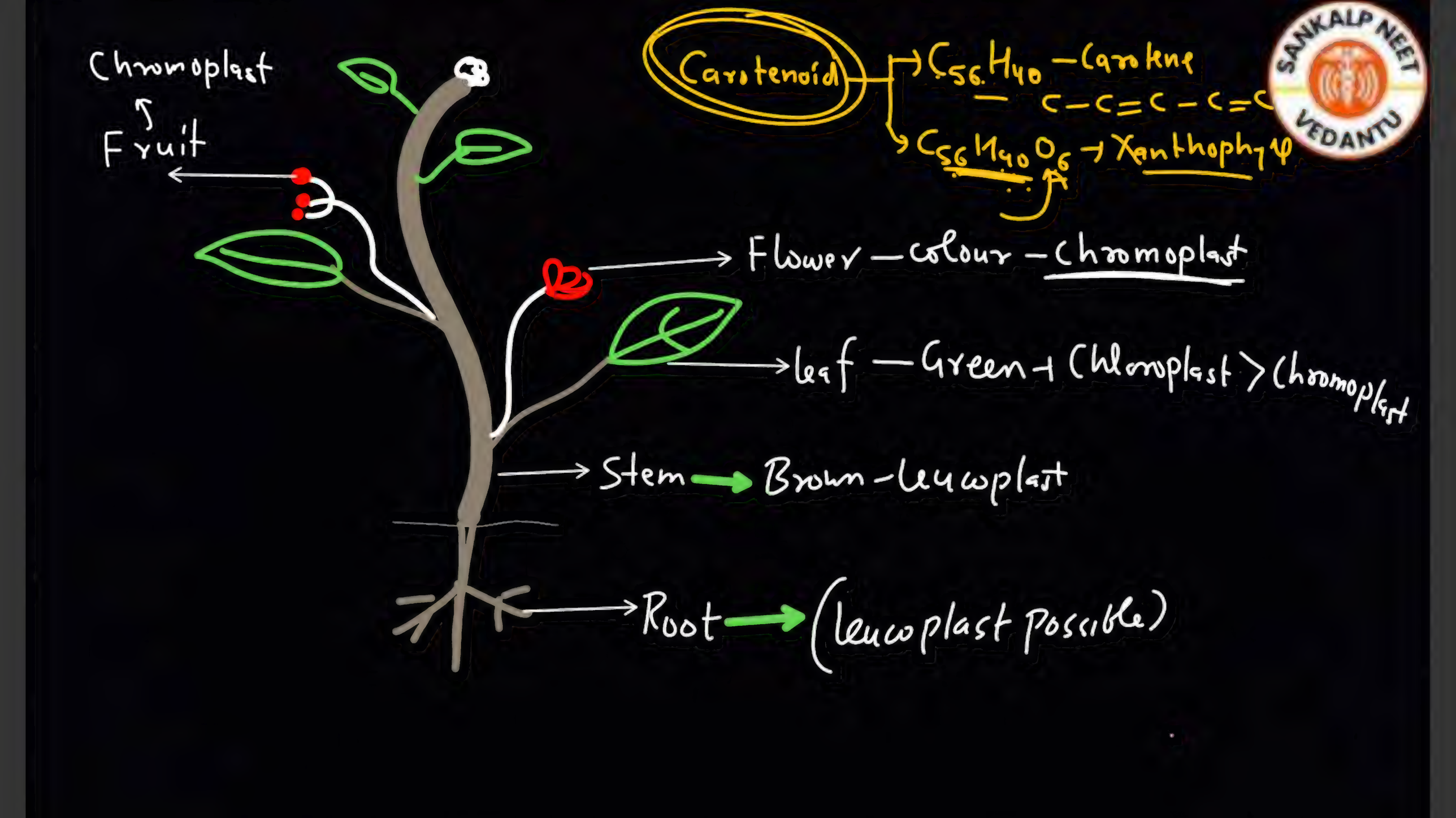
→ Visible in compound Microscope

Type of plastid, – On the Basis of Pigments

(a) Chloroplast (Green plastids) ⇔ Chlorophyll, Carotene & Xanthophyll (more is chlorophyll)

(b) Chromoplast (Other than Green) → Colour plastids – Carotene, Xanthophyll present

(c) Leucoplast → Colourless plastids


Chromoplast
Fruit
Carotenoid
$C_{56}H_{40}$ – Carotene
$C_{56}H_{40}O_6$ → Xanthophyll
Flower – colour – Chromoplast
leaf – Green → Chloroplast > Chromoplast
Stem → Brown – Leucoplast
Root → (Leucoplast possible)
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Type of plastids

	Chromoplast	Chloroplast	leucoplast
Present in	Flower, Fruit	Green part (Leaf, Green stem)	– Colourless part (Stem, Root)
Pigment	Carotene, Xanthophyll	Chlorophyll, Carotene, Xanothophyll	– Pigment Absent
Function	attract insect (Pollination), Attract Animal (Seed dispersal)	Photosynthesis	– Shape variable ✓

Type of leucoplast

(a) Amyloplast – Store starch (Ex – Potato tuber)

(b) Aleuronoplast – Store protein

(c) Elaioplast – Store oil & Fat

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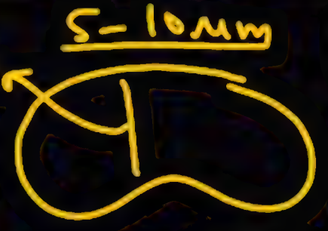
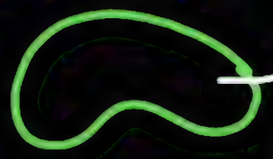
Chloroplast



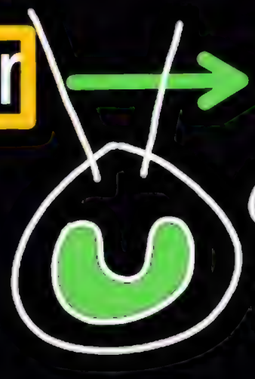
Size → diameter - 2-4 µm
length → 5-10 µm

shape →



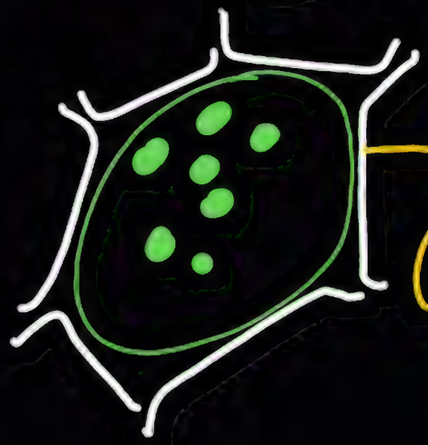
Flat / Dicoid - main shape
(Spiral (Spirogyra), Cup shape (Chlamydomonas), Reticulate) → Other shape in Algae

number →

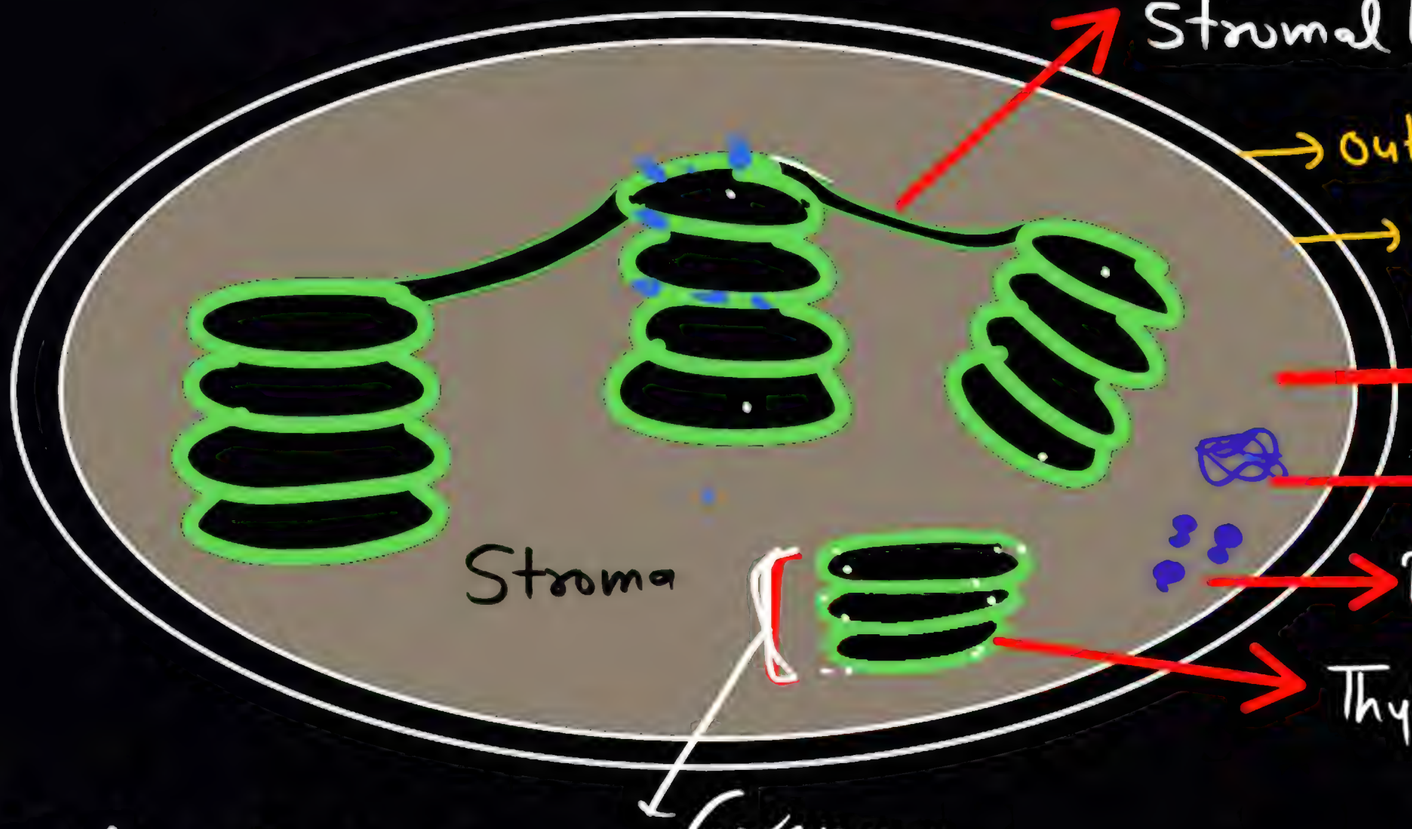


(Single cell Green Algae) Chlamydomonas
Single Chloroplast

Leaf
20-40 Chloroplast



Mesophyll cell
(main photosynthetic cell of leaf



Stromal lamellae

Outer Membrane

Inner Membrane

Stroma - Enzyme of Dark Rxn

DNA present

Ribosome present

Thylakoids

Granum

* Chloroplast - Double Membrane organelle
* Inner membrane - Surround stroma

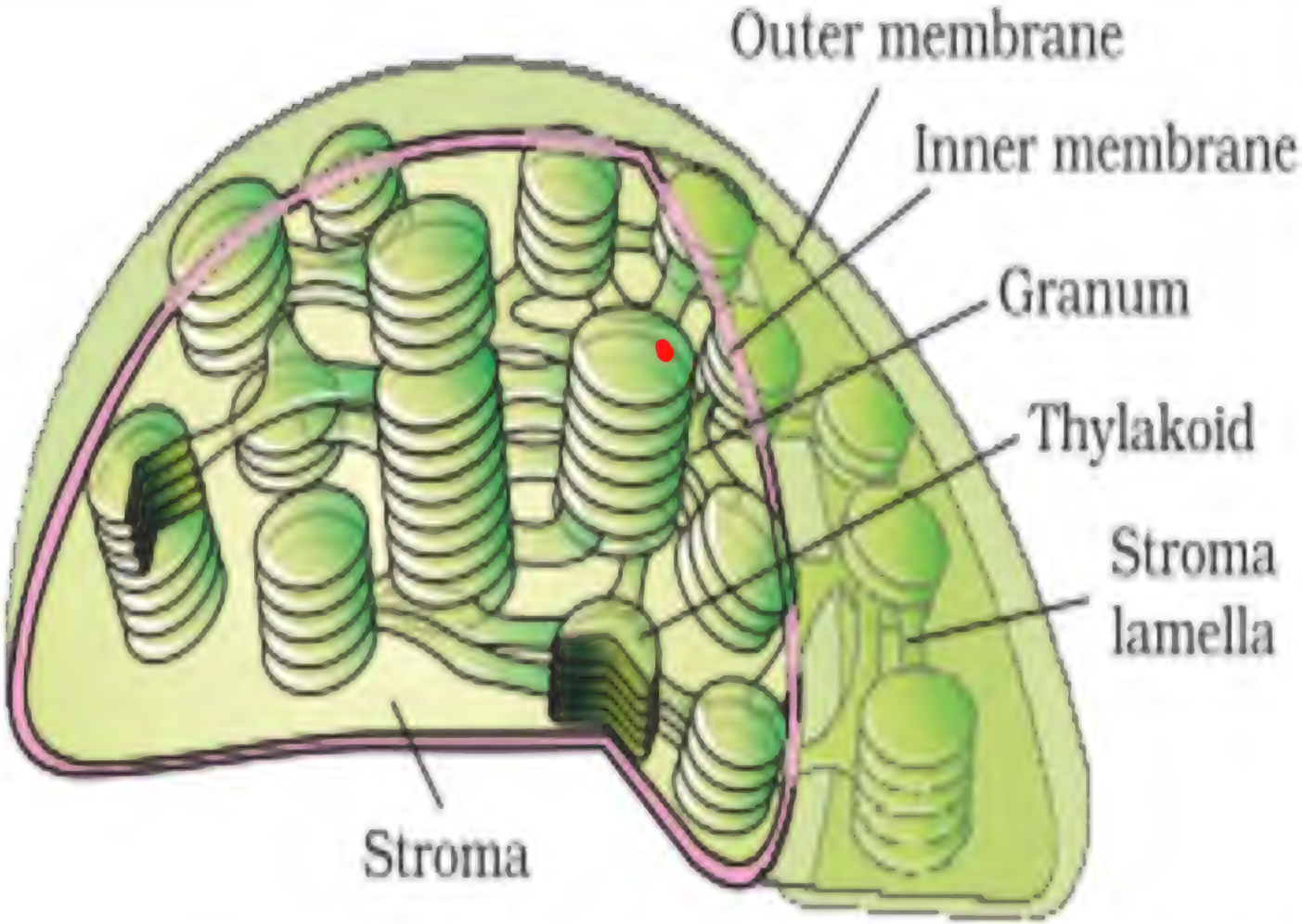
Outer membrane → Lipid Bilayer, permeable for water, Porins present

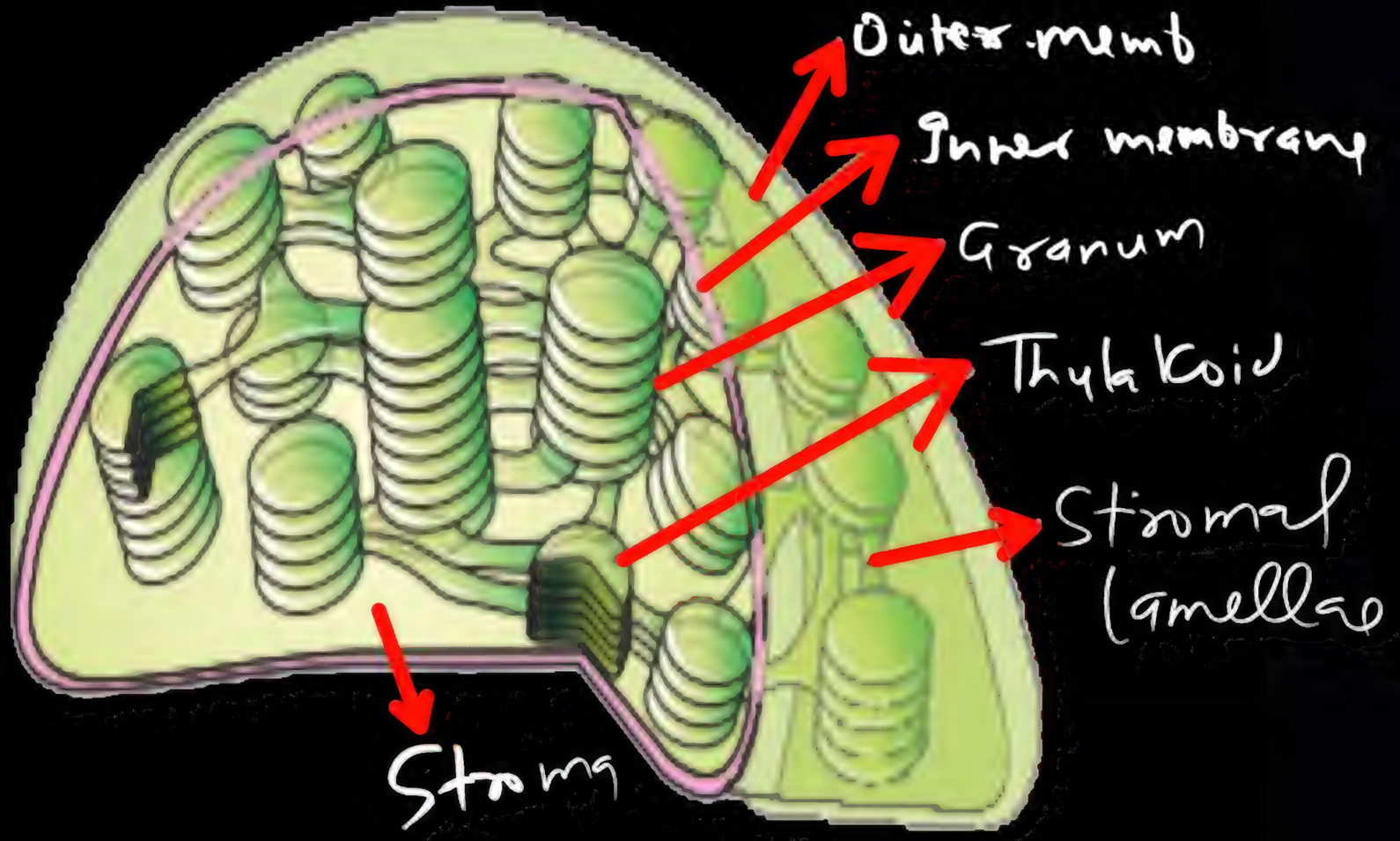
inner membrane → Lipid Bilayer, Surround Stroma

Stroma → Enzyme present – Dark Rxn → Sugar Form → Store starch
(RUBISCO)
→ double stranded, circular, single DNA present, RNA, Ribosome (70S) → Protein Form
→ Site of Sugar & Protein synthesis

Thylakoids → Flat sac like structure, Pigment present (Chlorophyll a & b, Carotene, Xanthophyll)
→ Thylakoid + Coin like Arrange – Granum
→ Two Granum is connected By – Stromal lamellae

Lumen
Thylakoid → Pigment attach → Light Rxn


Outer membrane
Inner membrane
Granum
Thylakoid
Stroma lamella
Stroma


Outer memb
Inner membrane
Granum
Thylakoid
Stromal lamellae
Stroma

8.5.5 Plastids

Plastids are found in all plant cells and in euglenoides. These are easily observed under the microscope as they are large. They bear some specific pigments, thus imparting specific colours to the plants. Based on the type of pigments plastids can be classified into **chloroplasts, chromoplasts** and **leucoplasts.**

The chloroplasts contain **chlorophyll** and carotenoid pigments which are responsible for trapping light energy essential for photosynthesis. In the chromoplasts fat soluble **carotenoid** pigments like carotene, xanthophylls and others are present. This gives the part of the plant a yellow, orange or red colour. The leucoplasts are the colourless plastids of varied shapes and sizes with stored nutrients: **Amyloplasts** store carbohydrates (starch), e.g., potato; **elaioplasts** store oils and fats whereas

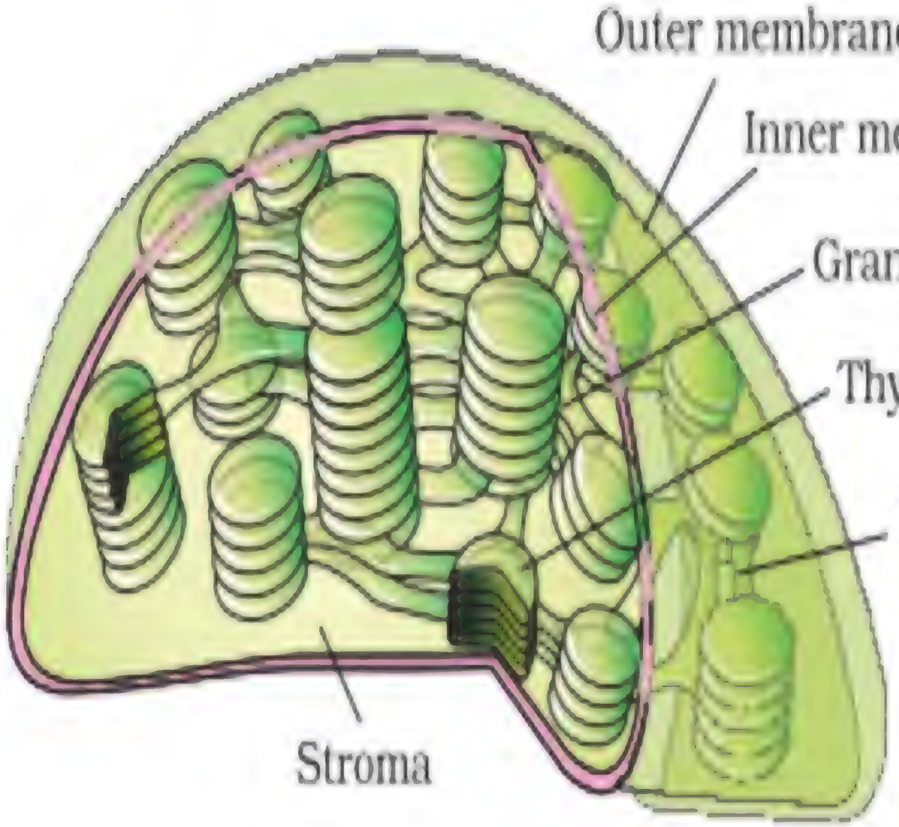


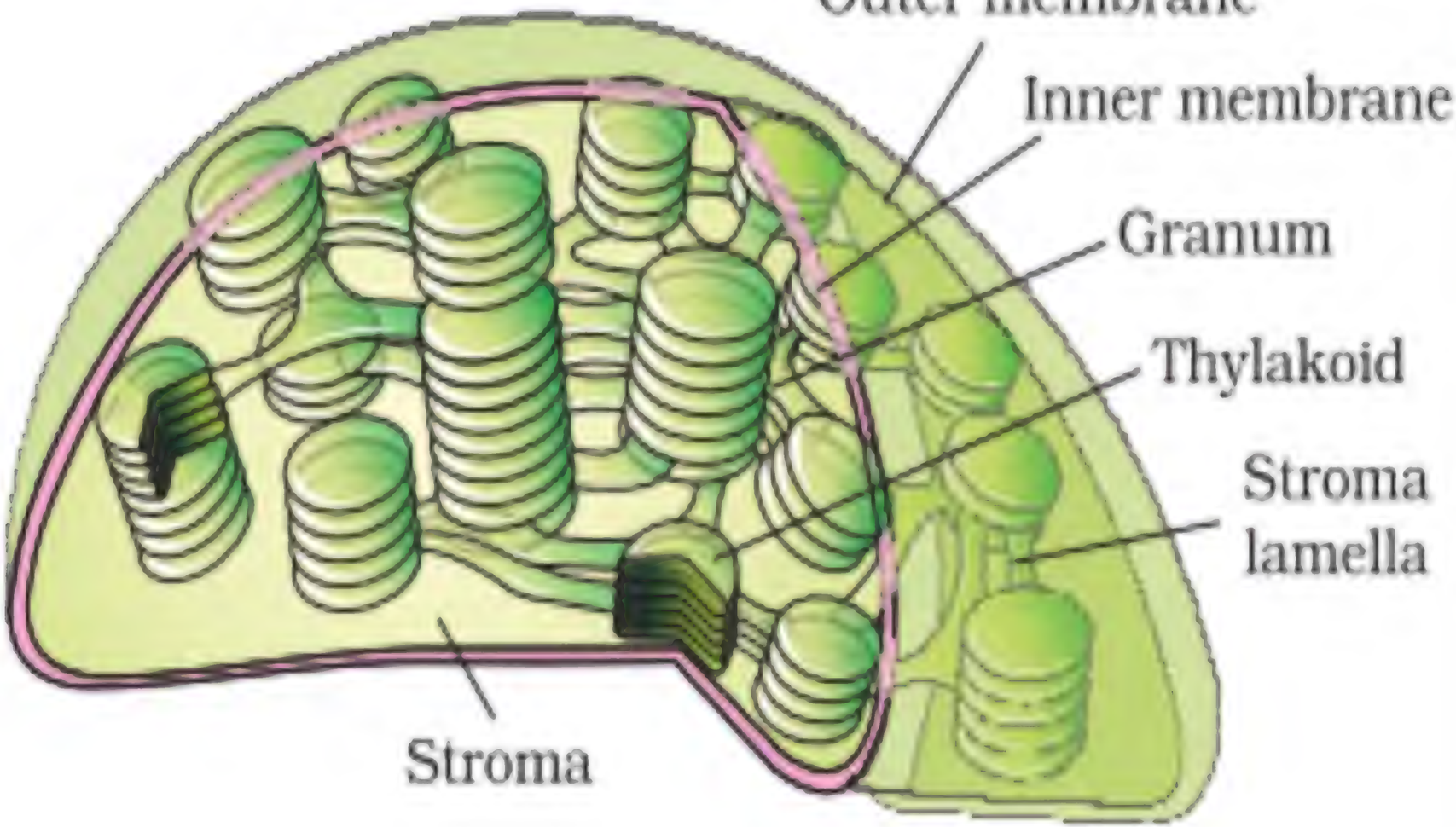
Figure 8.8 Sectional view of chloroplast

the **aleuroplasts** store proteins.

Majority of the chloroplasts of the green plants are found in the mesophyll cells of the leaves. These are lens-shaped, oval, spherical, discoid or even ribbon-like organelles having variable length (5-10μm) and width (2-4μm). Their number varies from 1 per cell of the *Chlamydomonas*, a green alga to 20-40 per cell in the mesophyll.

Like mitochondria, the chloroplasts are also double membrane bound. Of the two, the inner chloroplast membrane is relatively less permeable. The space limited by the

less permeable. The space limited by the inner membrane of the chloroplast is called the stroma. A number of organised flattened membranous sacs called the **thylakoids** are present in the stroma (Figure 8.8). Thylakoids are arranged in stacks like the piles of coins called grana (singular: granum) or the intergranal thylakoids. In addition, there are flat membranous tubules called the stroma lamellae connecting the thylakoids of the different grana. The membrane of the thylakoids enclose a space called a lumen. The stroma of the chloroplast contains enzymes required for the synthesis of carbohydrates and proteins. It also contains small double-stranded circular DNA molecules and ribosomes. Chlorophyll pigments are present in the thylakoids. The ribosomes of the chloroplasts are smaller (70S) than the cytoplasmic ribosomes (80S).


Outer membrane
Inner membrane
Granum
Thylakoid
Stroma lamella
Stroma

Chloroplast and Mitochondria

Similarity

- Double membrane ✓
- Porins ✓
- Double stranded circular DNA ✓
- 70 S Ribosome ✓
- Semi Autonomous → In chloroplast & Mitochondria many protein synthesis themself But some protein come From outside (with the help of nucleus)
- ATP synthesis occur in Both Mitochondria & Chloroplast
- Both Divide By Fission

Difference

Chloroplast	Mitochondria
– Pigments present For photosynthesis	No Pigments For photosynthesis
– H_2O Break, O_2 produce	– O_2 use, H_2O produce
– Size larger than mitochondria	

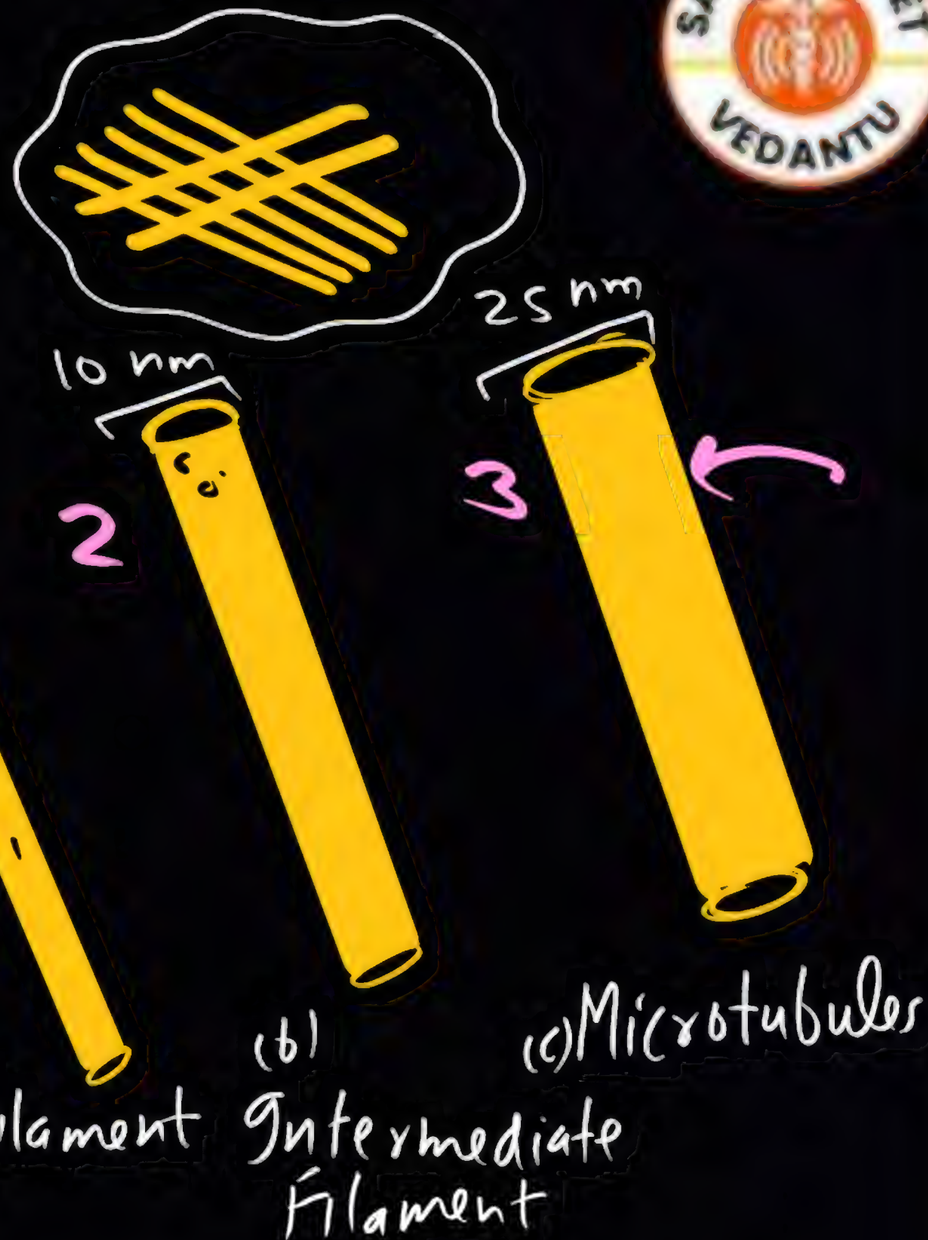
Cyto skeletal system

Cell ↓ Support ↓

Meaning – Inside Eukaryotic cell, Filamentous Elaborate network of protein

Feature –
(a) Filamentous
(b) present in cytoplasm
(c) made up of protein
(d) Type depend on diameter.

Function → Motility
→ Shape
→ Structural support



8.5.7 Cytoskeleton

An elaborate network of filamentous proteinaceous structures consisting of microtubules, microfilaments and intermediate filaments present in the cytoplasm is collectively referred to as the **cytoskeleton**. The cytoskeleton in a cell are involved in many functions such as mechanical support, motility, maintenance of the shape of the cell.

Threetype cytoskeletal Elements

(a) Microfilament
(Actin Filament)

Role - (a) Muscles
(b) Amoeboid Movement

Pseudopodia (Microfilament)

(b) Intermediate Filament
(lamins)

Inner membrane of nucleus

(c) Microtubule

- tubulin-α
- tubulin-β

↓ Present in

(a) Cillia & Flagella
(b) Spindle Fibre
(c) Centriole → Basal Body

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cell unit of life

lecture – 12

Botany

TARUN SIR

Topic

Cytoskeletal Elements

Nucleus

8.5.7 Cytoskeleton

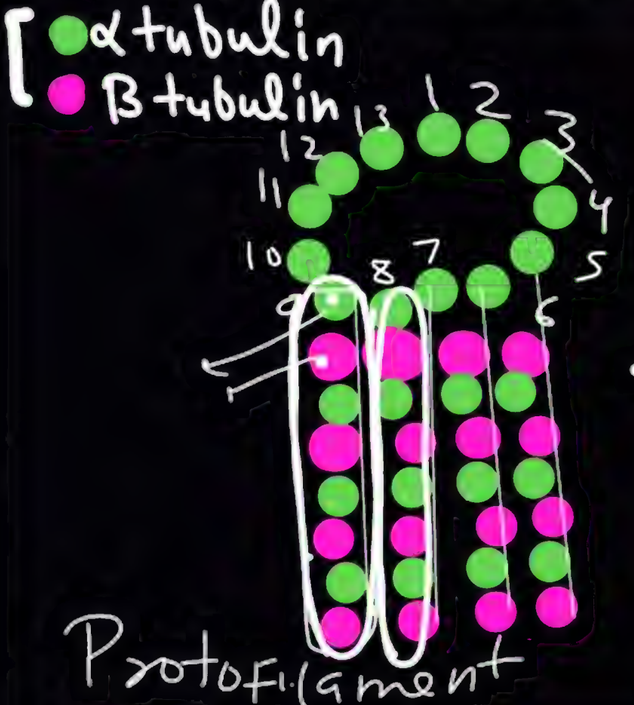
An elaborate network of filamentous proteinaceous structures consisting of microtubules, microfilaments and intermediate filaments present in the cytoplasm is collectively referred to as the **cytoskeleton**. The cytoskeleton in a cell are involved in many functions such as mechanical support, motility, maintenance of the shape of the cell.

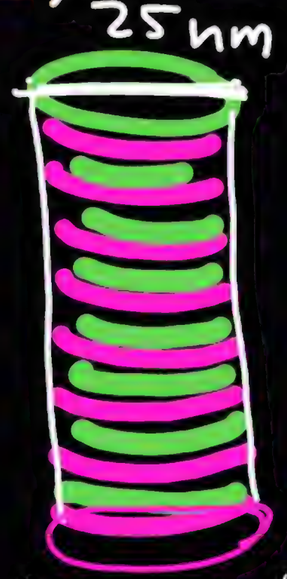
Cytoskeletal Elements

Examples

- Microtubule → 25 nm → Cilia, Flagella, Centriole, centrosome
- Microfilament → 5 nm
- Intermediate filament → 10 nm

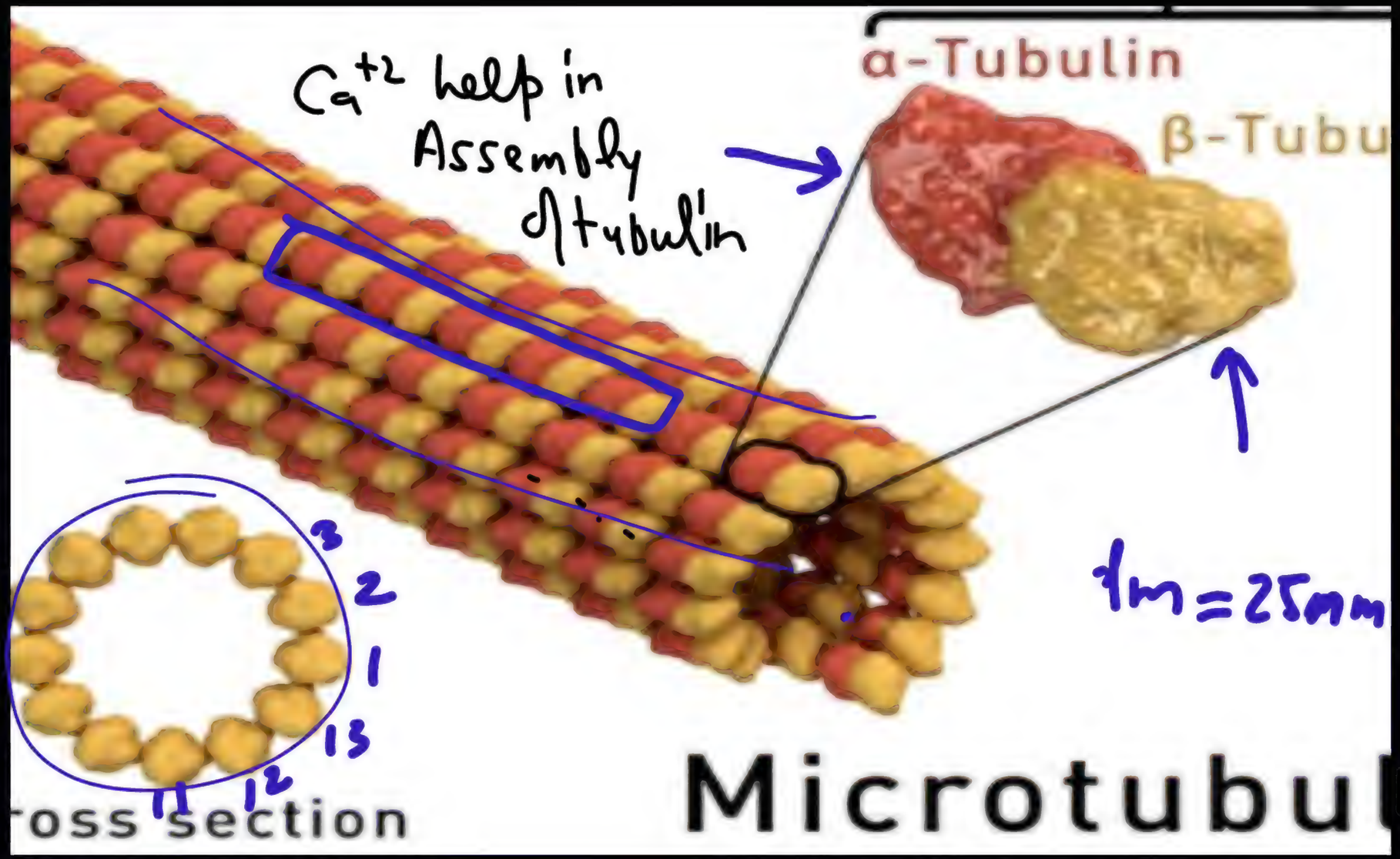
Microtubule (Structure)



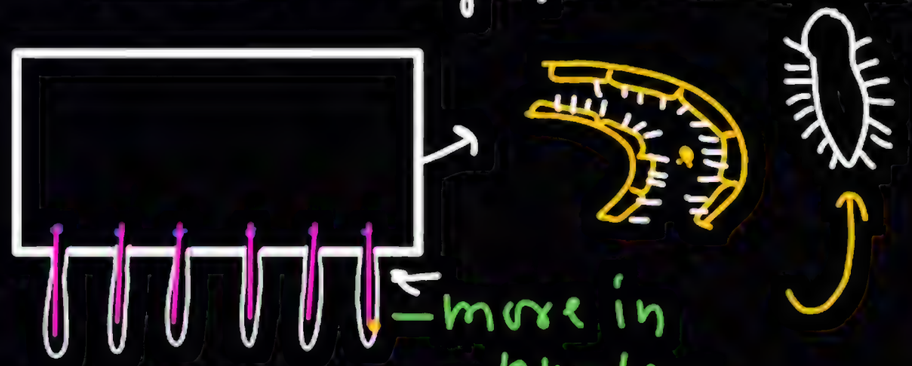


α-tubulin + β-tubulin
↓
Protofilament
↓ 13 protofilament
1 Microtubule

Structure From microtubule →
- Cilia, Flagella
- Centriole, Basal Body
- Spindle Fibre


Ca^{+2} help in Assembly of tubulin
α-Tubulin
β-Tubu
dm = 25nm
3
2
1
13
12
11
ross section
Microtubul

Cillia — Single cell - Parmoecium



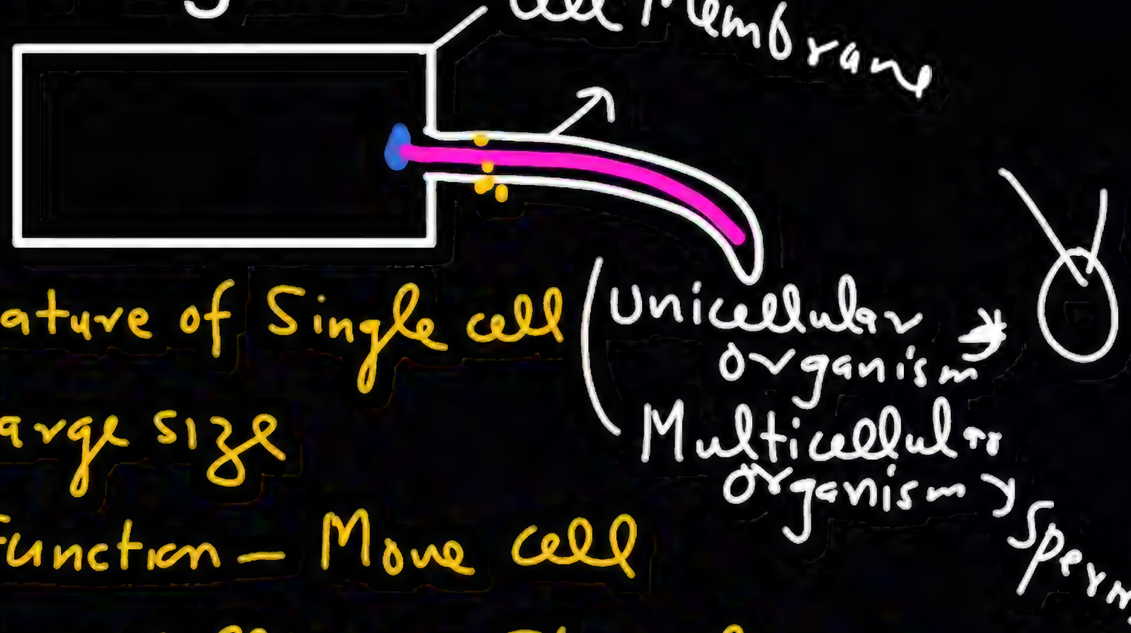
- more in number

- location - Unicellular organism (Parmoecium)
- In Human - ciliated Epithelium (trachea, Fallopian tube)

Function - It work like oar

It move cell or it move medium

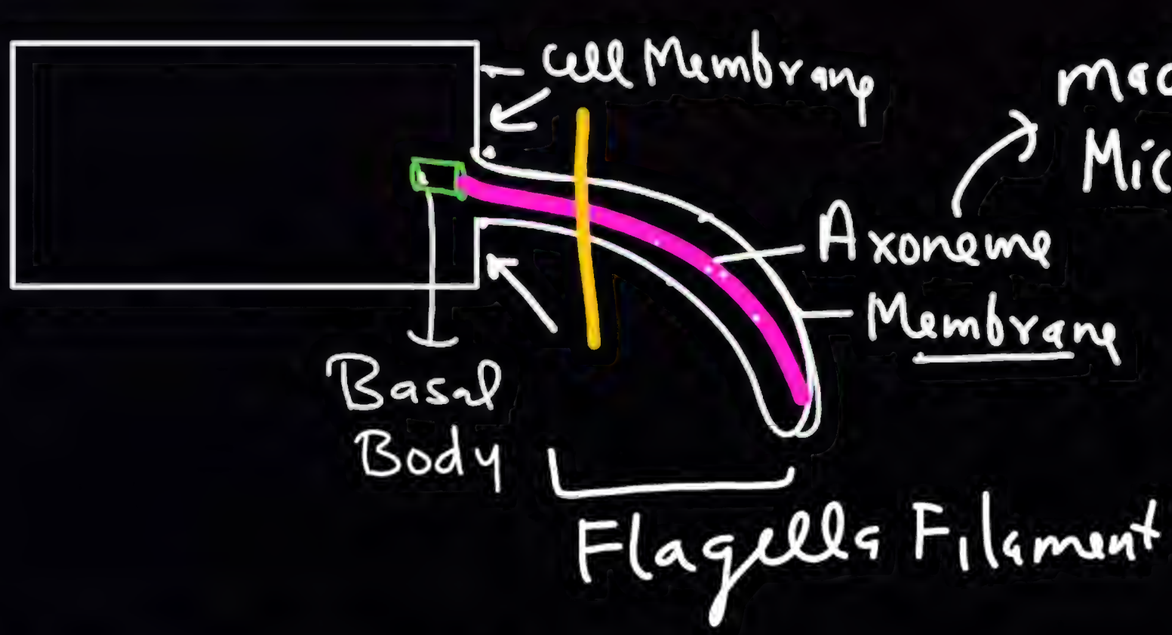
Flagella

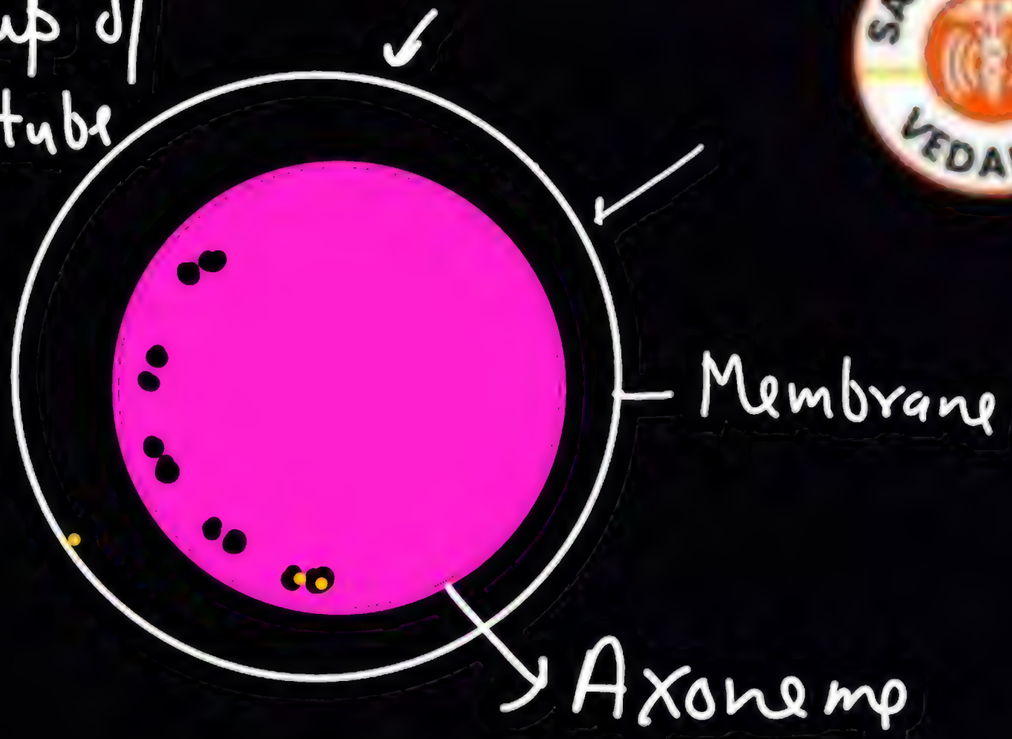


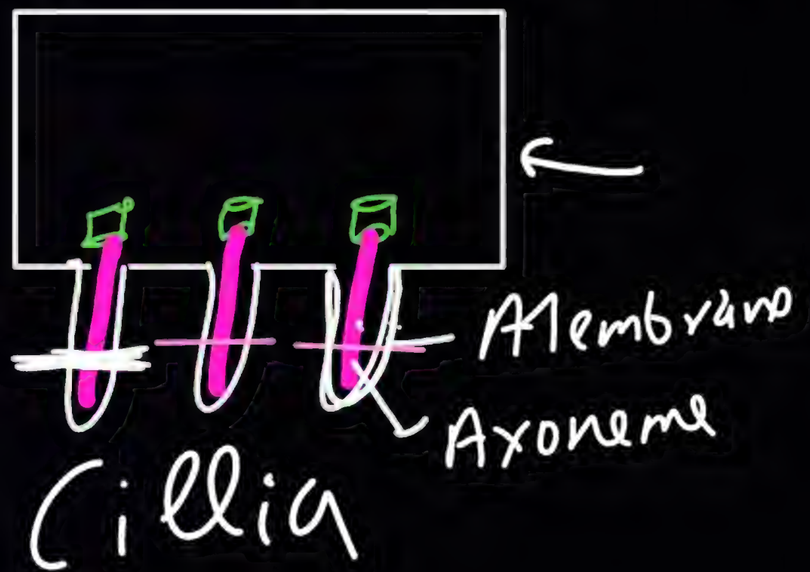
- Feature of Single cell
- large size
- Function - Move cell

note - Cillia and Flagella out Growth of Plasma membrane

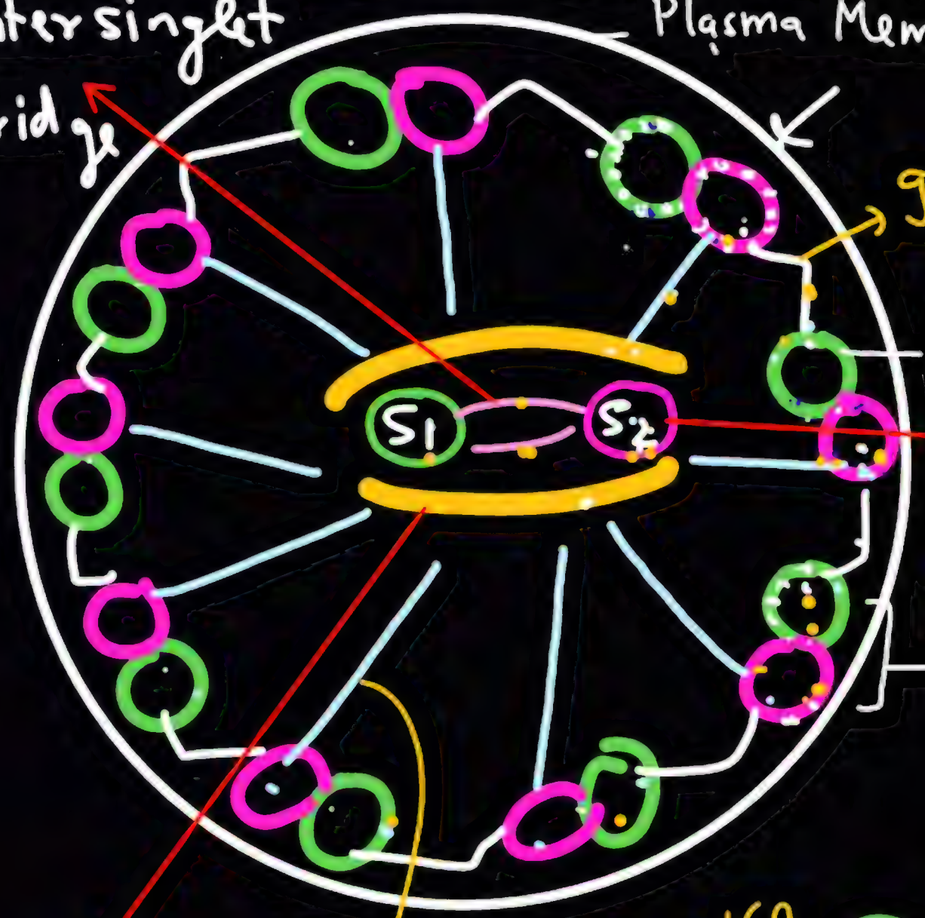
note → Prokaryotic Flagella structure is Different to Eukaryotes


Cell Membrane
made up of Microtubules
Axoneme
Membrane
Basal Body
Flagella Filament


Membrane
Axoneme


Membrane
Axoneme
Cilia

Structure of Axoneme



9+2 Arrangement

Axoneme

(a) two microtubule Form Doublet → peripheral Arrang

(b) 9 doublet → link By linker protein

(c) In centre, two microtubule not Doublet

(a) Central Microtubule cover By Sheath

(e) Each doublet link By Radial Spoke to sheath

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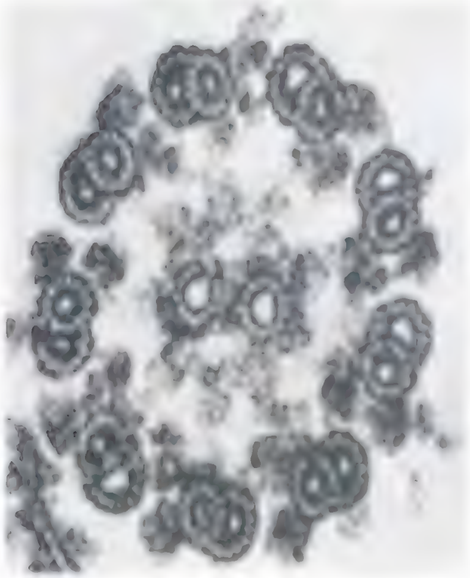
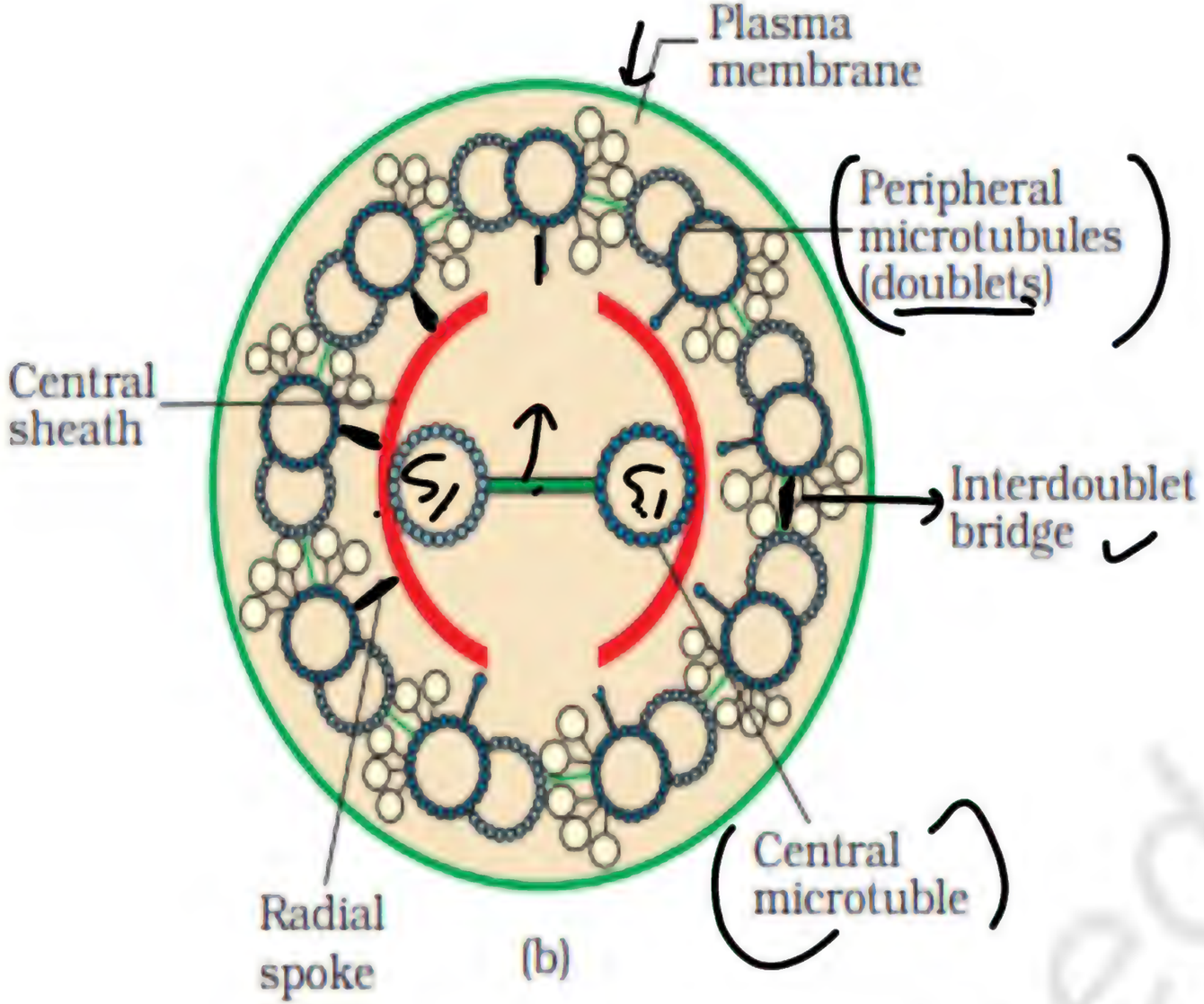
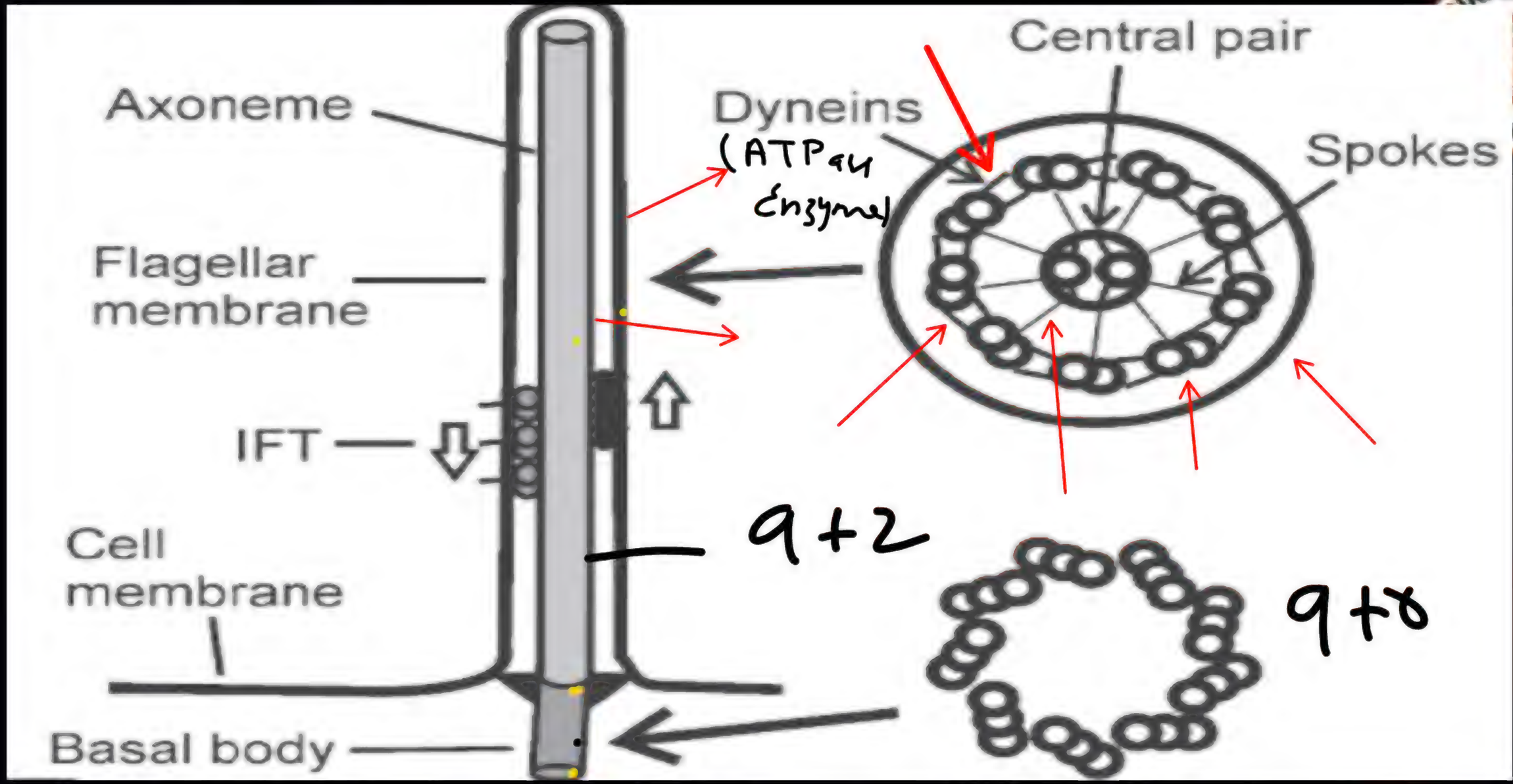
Electron microscope



(a)




Axoneme
Flagellar membrane
IFT
Cell membrane
Basal body
Dyneins
(ATPase Enzyme)
Central pair
Spokes
9+2
9+0

note— 9+2 Arrangement of microtubule in- Cillia and Flagella

→ Doublet = 9
→ Single = 2
→ Radial spoke = 9
→ Linkers → 9

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8.5.8 Cilia and Flagella

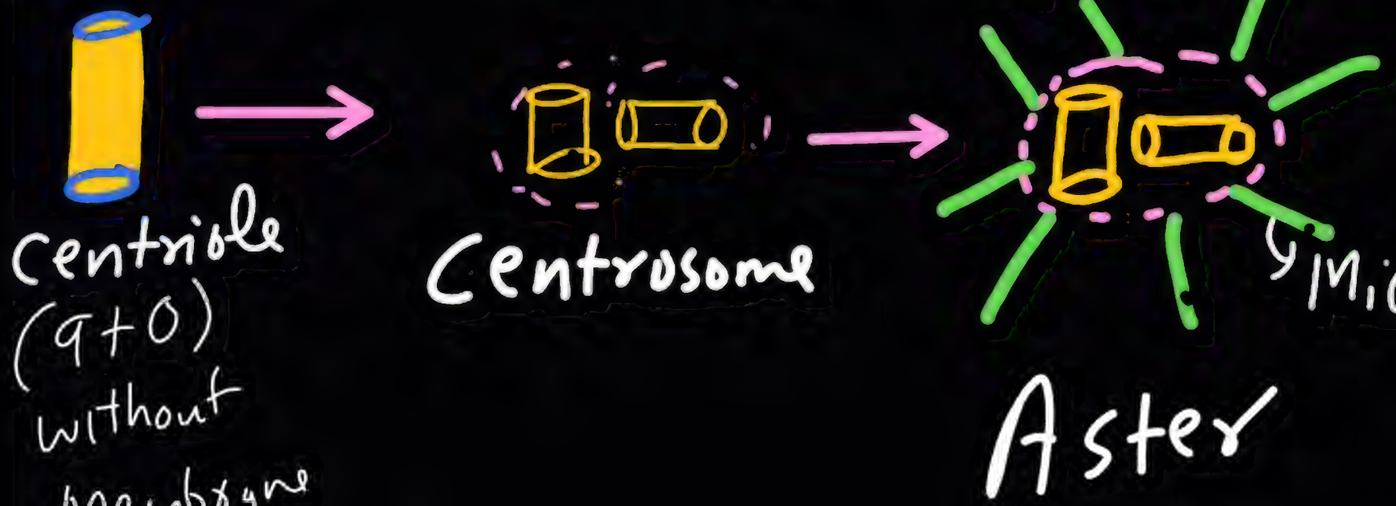
Cilia (sing.: cilium) and flagella (sing.: flagellum) are hair-like outgrowths of the cell membrane. Cilia are small structures which work like oars, causing the movement of either the cell or the surrounding fluid. Flagella are comparatively longer and responsible for cell movement. The prokaryotic bacteria also possess flagella but these are structurally different from that of the eukaryotic flagella.

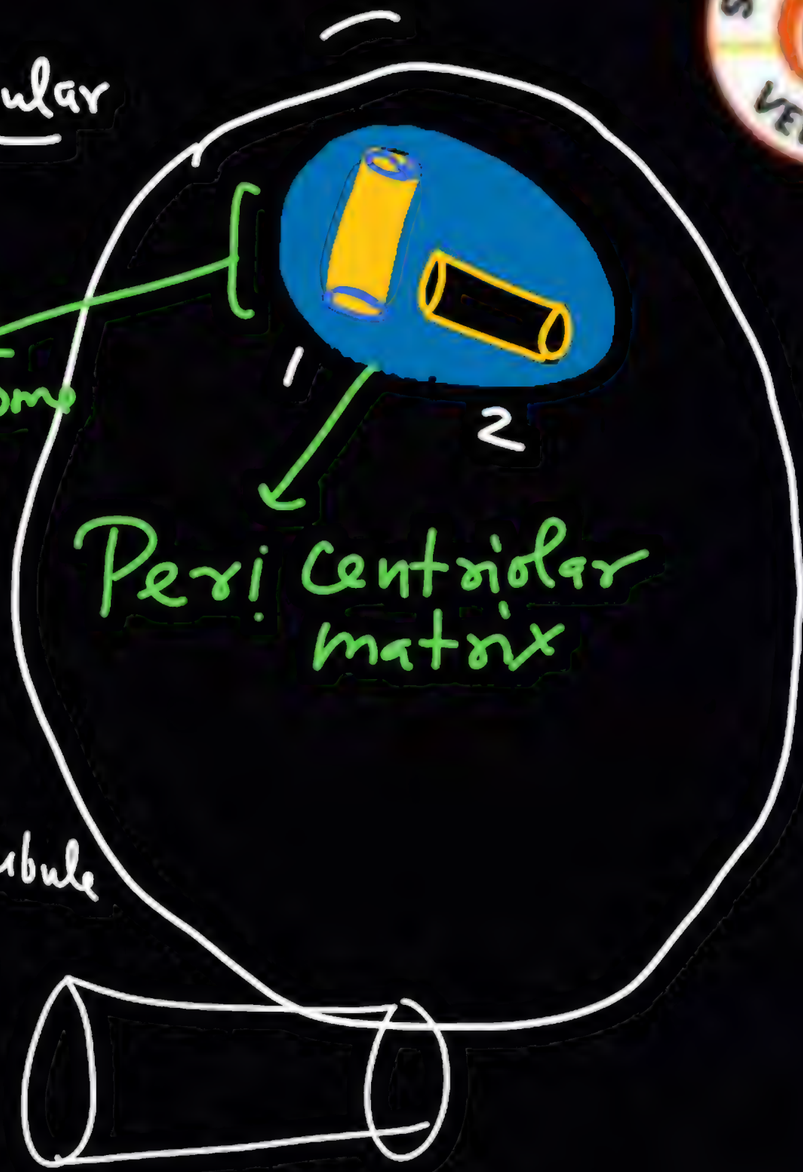
The electron microscopic study of a cilium or the flagellum show that they are covered with plasma membrane. Their core called the **axoneme**, possesses a number of microtubules running parallel to the long axis. The axoneme usually has nine doublets of radially arranged peripheral microtubules, and a pair of centrally located microtubules. Such an arrangement of axonemal microtubules is referred to as the 9+2 array (Figure 8.10). The central tubules are connected by bridges and is also enclosed by a central sheath, which is connected to one of the tubules of each peripheral doublets by a radial spoke. Thus, there are nine radial spokes. The peripheral doublets are also interconnected by linkers. Both the cilium and flagellum emerge from centriole-like structure called the basal bodies.

Centriole and Centrosome

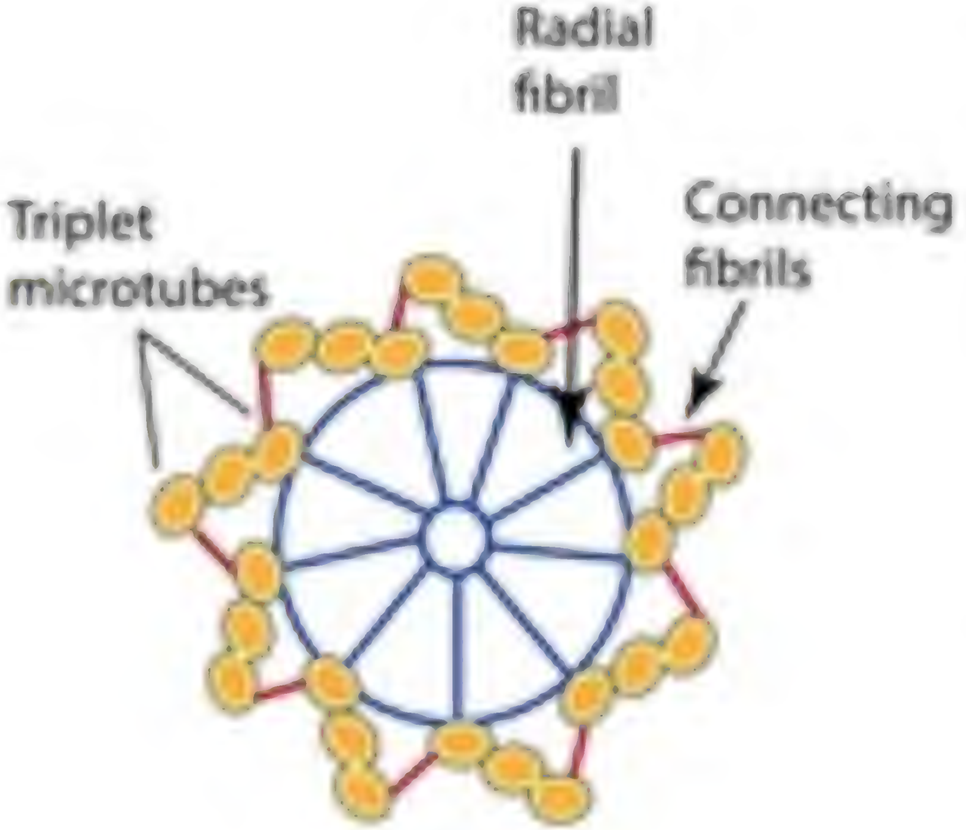
- In Animal cell → Two centriole Arrange perpendicular to Form Organelle known as Centrosome

- Around centriole → pericentriolar material present

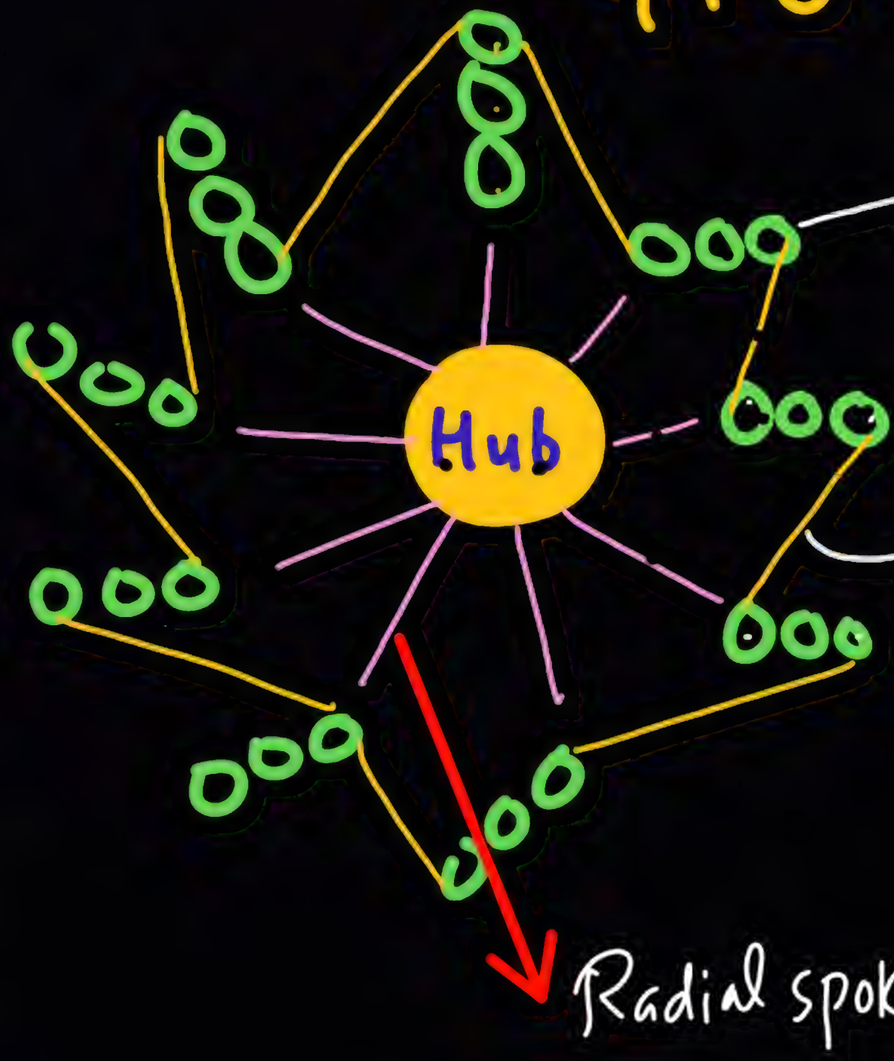




Triplet microtubes
Connecting fibrils

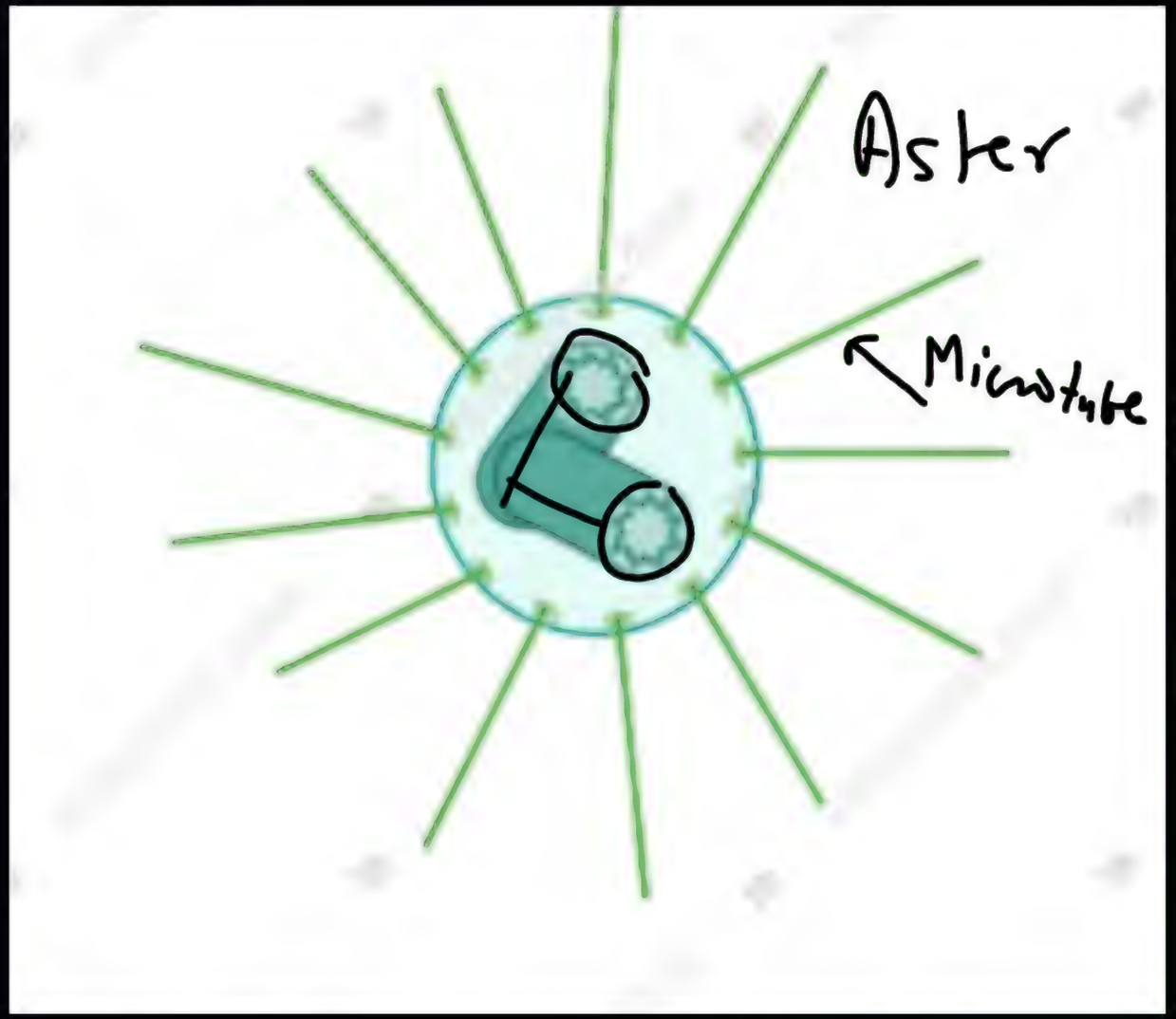

Radial fibril
Triplet microtubes
Connecting fibrils

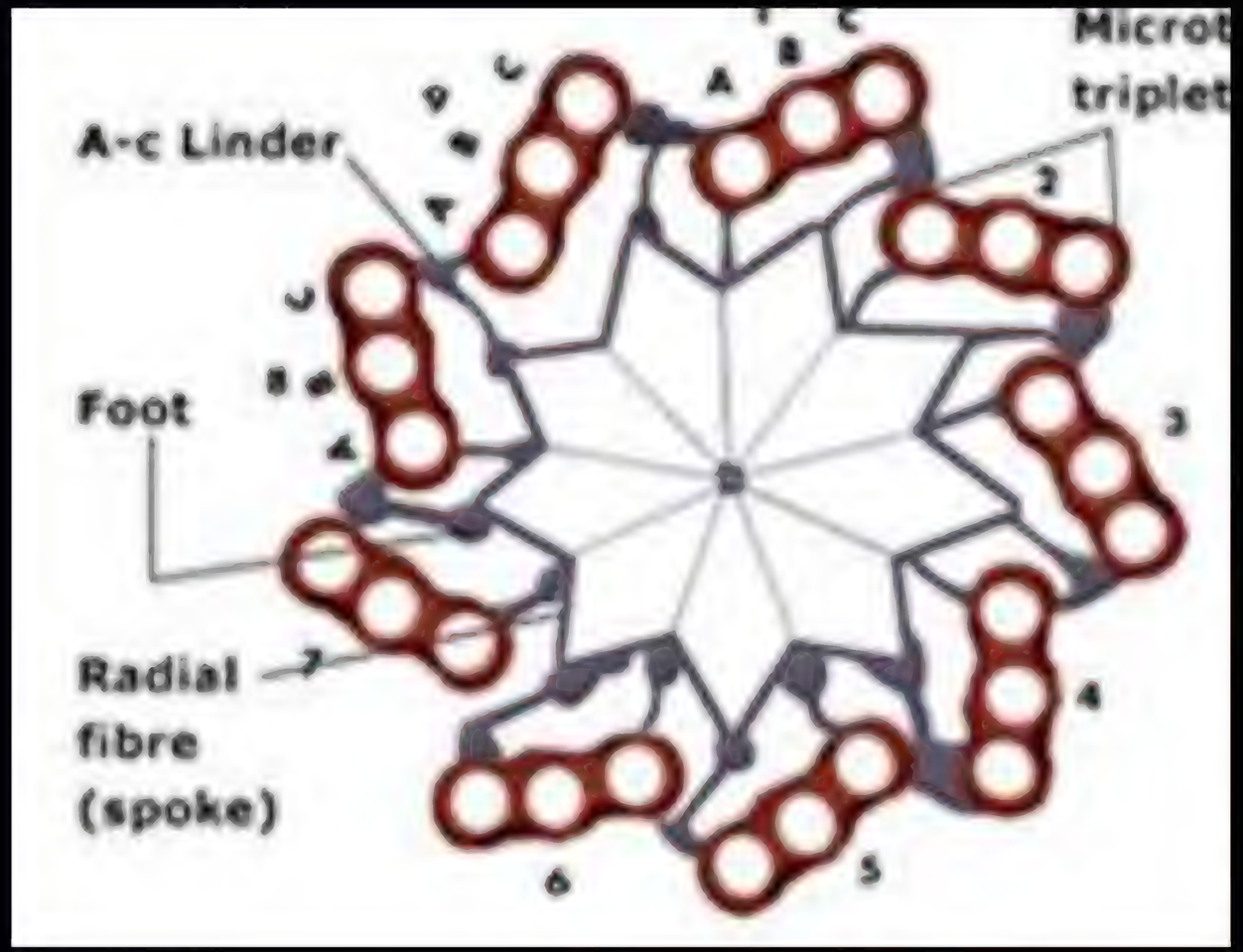
9+0 arrangement



* Centriole →

- 9 triplet present ✓ (Peripheral)
- Central proteinaceous Hub
- From Hub, Radial Spoke comes
- Cartwheel like Structure

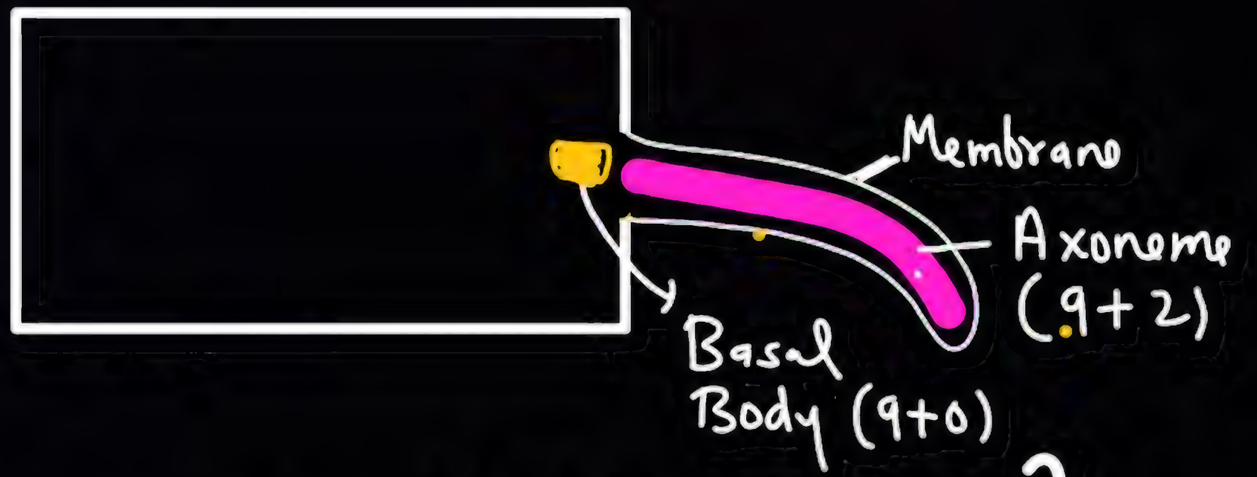

Aster
Microtube


A-c Linder
Foot
Radial
fibre
(spoke)
Microt
triplet
A
B
C
1
2
3
4
5
6
7
8
9

8.5.9 Centrosome and Centrioles

Centrosome is an organelle usually containing two cylindrical structures called centrioles. They are surrounded by amorphous pericentriolar materials. Both the centrioles in a centrosome lie perpendicular to each other in which each has an organisation like the cartwheel. They are

made up of nine evenly spaced peripheral fibrils of tubulin protein. Each of the peripheral fibril is a triplet. The adjacent triplets are also linked. The central part of the proximal region of the centriole is also proteinaceous and called the **hub**, which is connected with tubules of the peripheral triplets by radial **spokes** made of protein. The centrioles form the basal body of cilia or flagella, and spindle fibres that give rise to spindle apparatus during cell division in animal cells.



Centriole → centrosome → Aster
→ Basal Body
] 9+0

9+2 → cilia
(Axoneme) → Flagella
] 9+2

(two Aster + Spindle Fibre = Spindle Apparatus)

Nucleus

Discovery – 1831 – Robert Brown – Observe nucleus ✓

Flemming → Inside nucleus material stain with Basic dye and named as chromatin

We study nucleus in two stage

In Eukaryotic cell → Proper nucleus

Visible in interphase (cell is not Dividing)

Cell cycle

$G_1 + S + G_2$ = Interphase

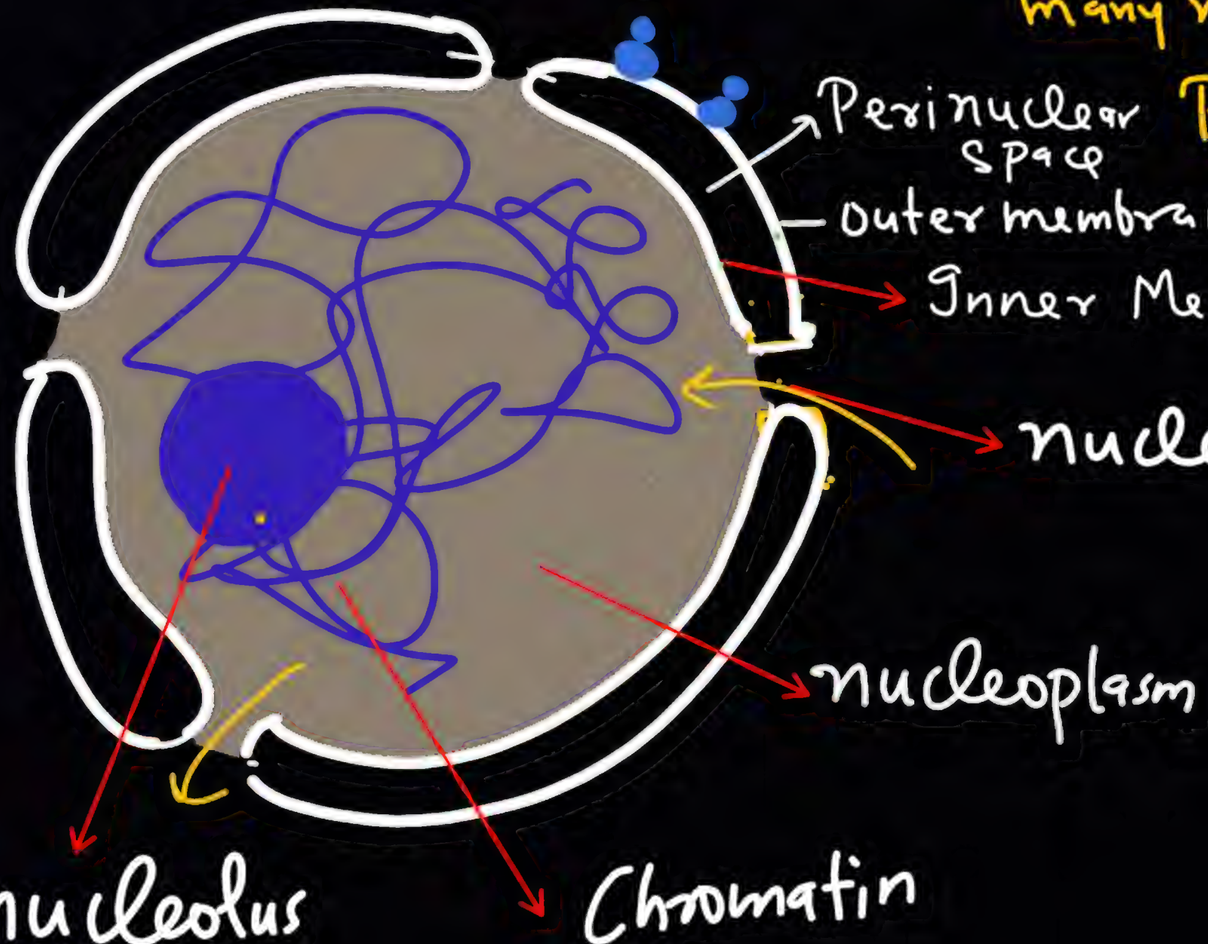
M-Phase → Chromosome present

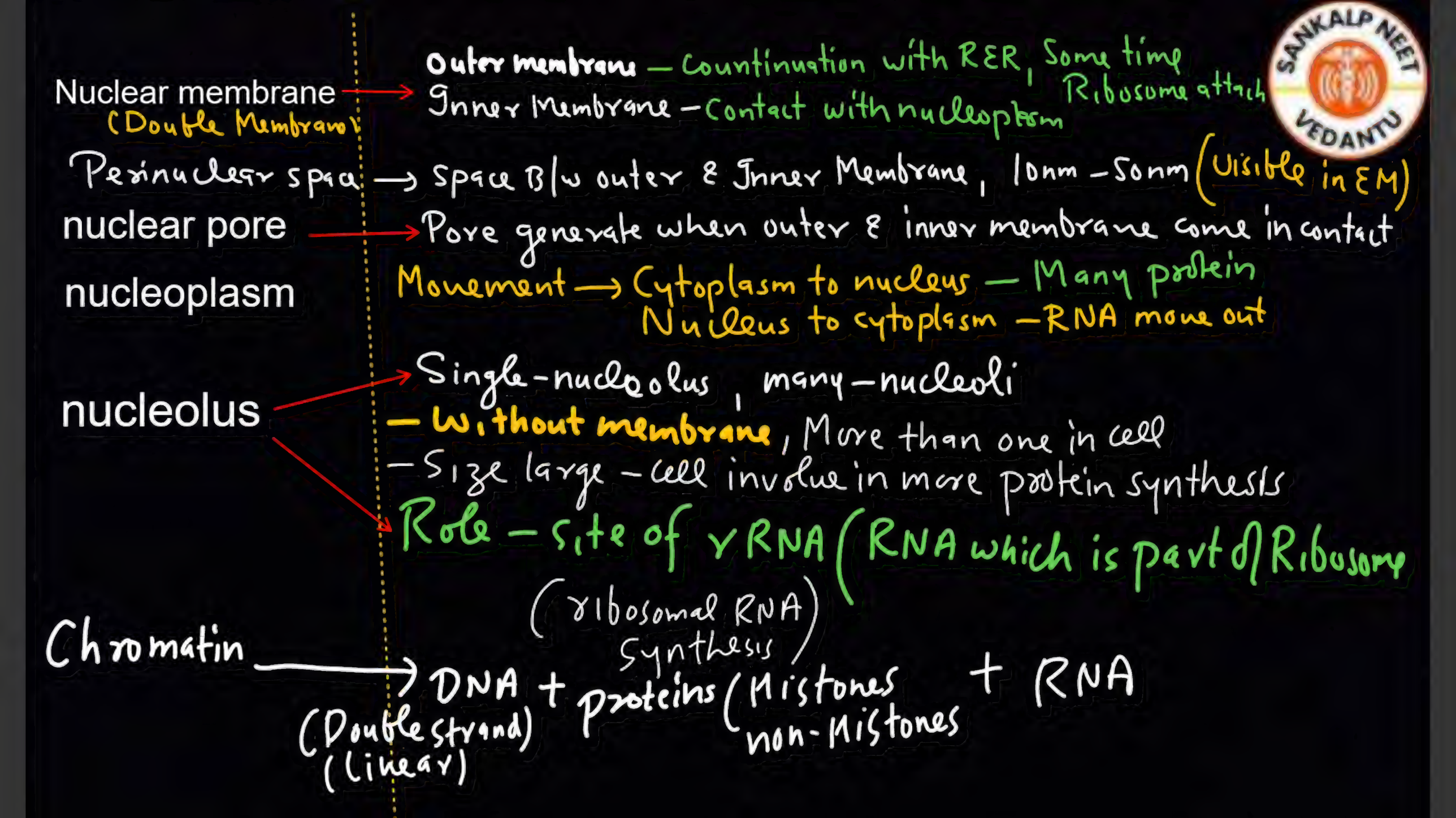
Interphase

(when cell Dividing) M-Phase

Interphase nucleus

(number – normally one single nucleus
without nucleus – RBC, Sieve tube
many nuclei → Tapetum, Fungi Aseptate hyphae)
Paramoecium → two nucleus




Nuclear membrane
(Double Membrane)
Outer membrane – Countinuation with RER, Some time Ribosome attach
Inner Membrane – Contact with nucleoplasm
Perinuclear space → Space B/w outer & Inner Membrane, 10nm – 50nm (Visible in EM)
nuclear pore → Pore generate when outer & inner membrane come in contact
nucleoplasm
Movement → Cytoplasm to nucleus – Many protein
Nucleus to cytoplasm – RNA move out
nucleolus
Single – nucleolus, many – nucleoli
– Without membrane, More than one in cell
– Size large – cell involve in more protein synthesis
Role – Site of rRNA (RNA which is part of Ribosome
(ribosomal RNA)
Synthesis
Chromatin → DNA + Proteins (Histones + RNA
non-Histones
(Double strand)
(linear)
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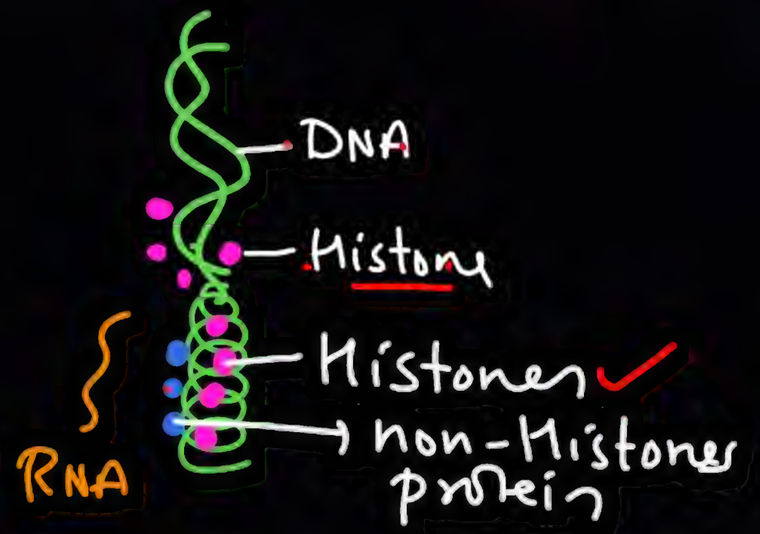

Chromatin (DNA + RNA + protein (Histones non Histones)

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Cell cycle and cell division

lecture - 1

Botany

TARUN SIR

Topics

- Basics of cell cycle ✓
- Mitosis ✓
- Meiosis ✓
- Questions ✓

number of Question = 4-5 — 2024 ↑ 2023

level → Easy to medium

Today's Goal

Basics of cell cycle ✓

(Cell cycle
Phases
Amount)
of DNA

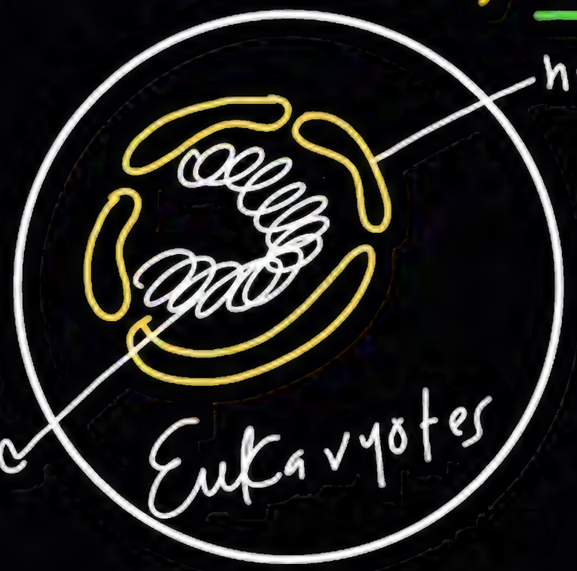
Basics of DNA Chromatin and chromosome

What we know ⟶

(a) Prokaryotic DNA is Circular, ds, naked (without membrane) →

(b) Eukaryotic DNA is in nucleus → Interphase – Chromatin visible (not Divisible)

→ M-phase Chromosome visible



What is DNA, Chromatin and Chromosome

- Bacteria DNA is naked, not termed as Chromatin

- Eukaryotic cell DNA

] DNA (open Form)

] Chromatin (Condensed Form)
- Visible inside nucleus

] Chromosome - Condensed Form of Chromatin
(Visible only when cell Divide)

observation

* Cell Diursion occur in Both prokaryotic cell & Eukaryotic cell ✓

* Chromatin visible in ——— When Eukaryotic cell have nucleus is in interphase

* Chromosome visible in — when cell Divide

Questions

Q1 Chromosome visible in

(a) E. coli (b) Streptococcus (c) neuron (d) none

(E. coli ✗, Streptococcus ✗, neuron ✓ (not Dividing), none ✓)

Q2 DNA present in

(a) E. coli (b) Yeast (c) Mycoplasma (d) all

(Yeast (Eukaryotes), all ✓)

Q3 Chromatin visible in

(a) E. coli (b) Skin cell (c) Dividing cell (d) all

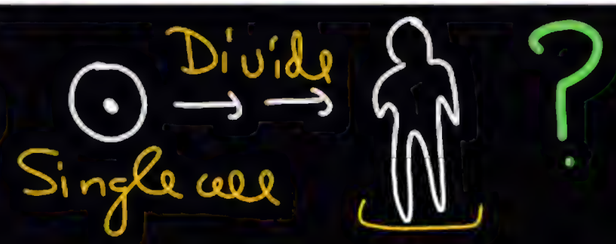
(Chromatin: E. coli ✗, Skin cell ✓, Dividing cell ✗ (chromosome), all ✗)

Q4 Which not visible together in cell (new Question)

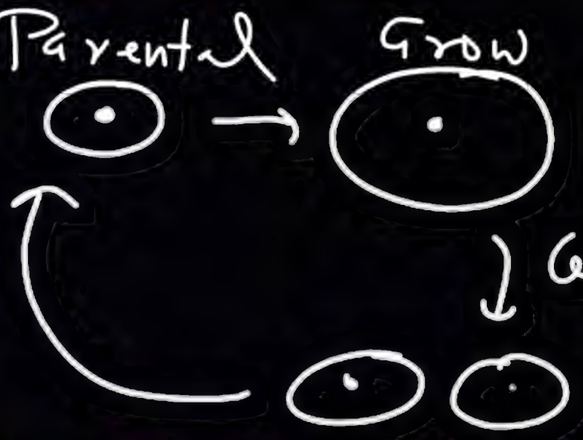
(a) ER & Golgi (b) Nucleus & Nucleolus (c) Nucleolus & chromosome (d) all

(ER & Golgi ✓, Nucleus & Nucleolus ✓, Nucleolus & chromosome ✗, all ✗)

How new cell Form



- Cell Division Important process ✓
- Do you know → How a single cell Form a large size organism?



Any cell ⟶ Growth occur ⟶ cell Divide (two progeny cell Form)

Divide Again ← Growth occur

* Growth & Reproduction (cell Division) important Feature of Organism

Statement

Are you aware that all organisms, even the largest, start their life from a single cell? You may wonder how a single cell then goes on to form such large organisms. Growth and reproduction are characteristics of cells, indeed of all living organisms. All cells reproduce by dividing into two, with each parental cell giving rise to two daughter cells each time they divide. These newly formed daughter cells can themselves grow and divide, giving rise to a new cell population that is formed by the growth and division of a single parental cell and its progeny. In other words, such cycles of growth and division allow a single cell to form a structure consisting of millions of cells.

Question

Observation:-

(1) Every cell prokaryotic or Eukaryotic can Divide

(2) large size or small size organisms are product of cell Division

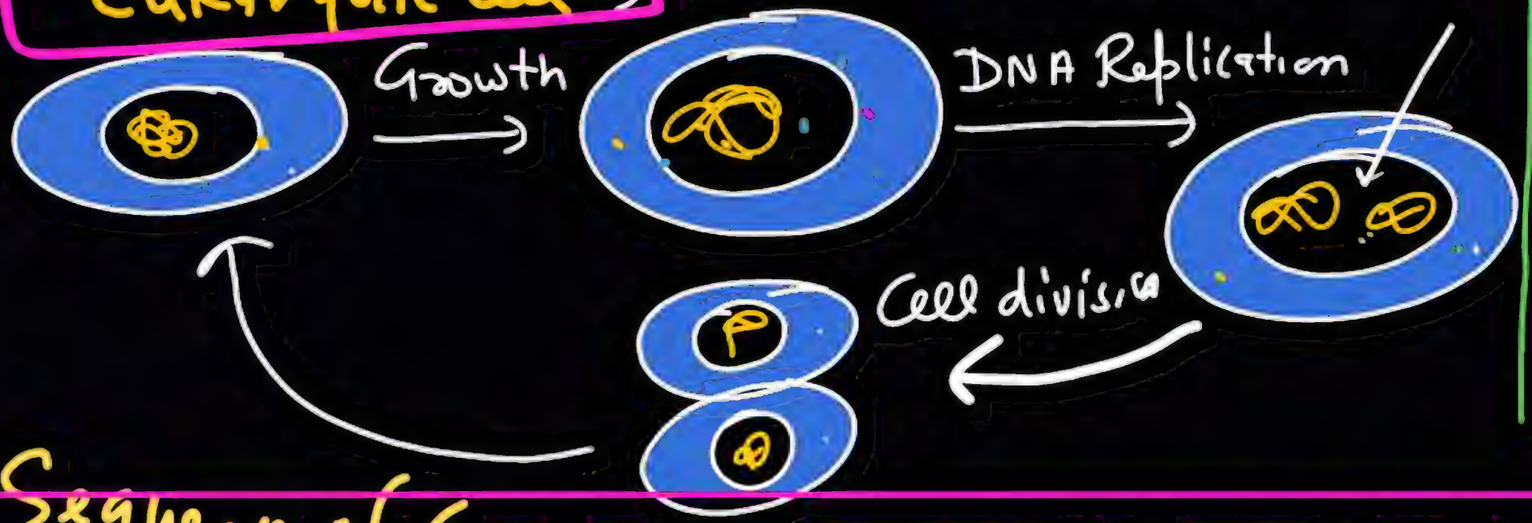
(3) A single cell Grow and Divide into two Daughter cell Which Again can Grow and Divide to Form organism with large number of cell

what is cell Cycle — Study For Eukaryote

→ Cell division is a very important process in all living organisms. (Prokaryotes, Eukaryotes)

- For cell Division → cell Growth → DNA Replication → Divide into two daughter

Eukaryotic cell →



Prokaryotic cell
- ✓ DNA Double
- ✓ Divide

But Prokaryotes no nucleus (Proper Change not Visible

Sequence of Event → where cell Grow, DNA Double and Divide into two cell → known as cell Cycle – Study For Eukaryote

Feature of cell cycle

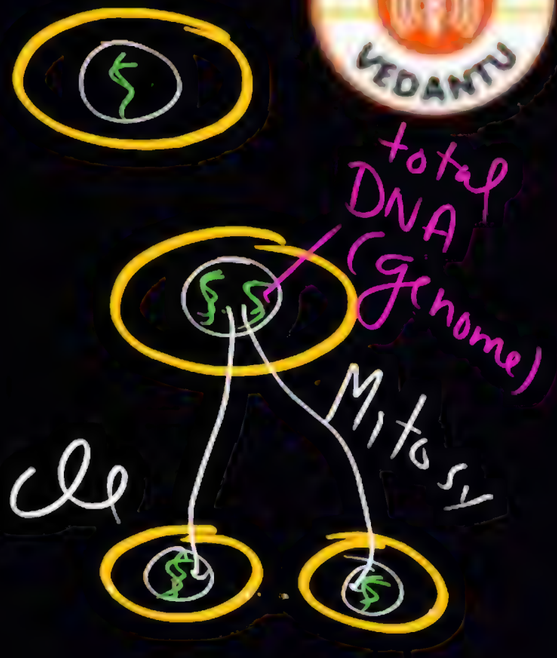
(a) Cell cycle observe in – Eukaryotic cell

(b) It is coordinated process – Sequence of Event is Fix

(c) DNA Replication occur in one specific phase
But Cytoplasm inc. countinuously in cell cycle

(d) all phases are under genetic control

(e) Intact genome pass on to progeny cell



Q) Which not common in Prokaryote & Eukaryotes

(a) DNA get Double (b) cell can Divide (c) DNA Double in S-Phase (d) all not in prokaryote

Q5 S-I - DNA Replication occur in all phase of cell cycle

S-II all phase of cell cycle is under genetic control

(a) S-I correct (b) S-II Correct (c) Both correct (d) Both Wrong

10.1 Cell Cycle

Cell division is a very important process in all living organisms. During the division of a cell, DNA replication and cell growth also take place. All these processes, i.e., cell division, DNA replication and cell growth, hence, have to take place in a coordinated way to ensure correct division and formation of progeny cells containing intact genomes. The sequence of events by which a cell duplicates its genome, synthesises the other constituents of the cell and eventually divides into two daughter cells is termed **cell cycle**. Although cell growth (in terms of cytoplasmic increase) is a continuous process, DNA synthesis occurs only during one specific stage in the cell cycle. The replicated chromosomes (DNA) are then distributed to daughter nuclei by a complex series of events during cell division. These events are themselves under genetic control.

Cell Cycle — Detail

* Study only in Eukaryotes, not in prokaryotes

* Cell cycle → changes occur in cytoplasm and nucleus

* Changes are known as phases

Phases of cell cycle

① – M-phase → Cell Divide into two daughter cell

② S-phase → S = Synthesis – DNA Double

③ G_1 – Phase – Gap-1 → It is Gap | time Gap
B/w Cell Division & start of DNA Replication

④ G_2 – Phase – Gap B/w
End of DNA Replication
& Start of Division

Q $M \rightarrow G_1 \rightarrow S \rightarrow G_2 \rightarrow M$

1	$M \rightarrow G_1 \rightarrow S \rightarrow G_2$
2	$G_1 \rightarrow S \rightarrow G_2 \rightarrow M$ ✓ more correct

cell cycle is Divided into two phases

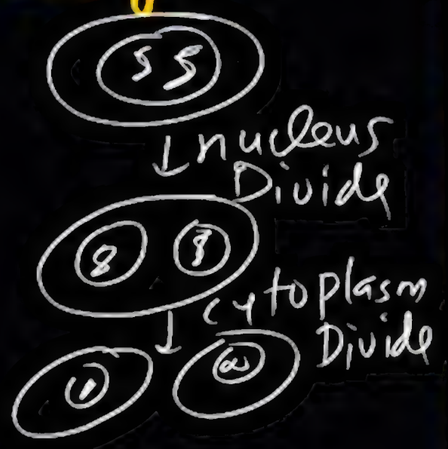
Cell Divide

M-phase – Mitosis
(Cell Division occur)

When cell Divide → two changes

(a) nucleus Divide ✓
– Karyokinesis

(b) Cytokinesis
– Cytoplasm Divide



time – 5% of total Cell cycle

Q M-phase start with
(a) Karyokinesis (b) Cytokinesis
(c) Start of Karyokinesis (d) End of Cytokinesis

Cell not Divide

Interphase

– It involve time B/w two successive M-phase
– It is time B/w End of one M-phase & start of next M-phase
– $(G_1 + S + G_2)$ → more than 95% time of cell cycle
It is also known as Resting phase
In comparison to M-phase no cell Division occur But DNA Replication & Growth occur

We need to study Following topics

1. Time of phases ✓
2. Changes occur in phase ✓
3. Amount and ploidy of DNA ✓
   (2C, C) (n, 2n)

For Cell cycle topic Study

Time for Different phases

Cell cycle = 24 hr
1 hr
3-4
8-12
6-8

- Prokaryotic cell – not show phases of cell cycle
- Some Eukaryotic cell
  - (a) Yeast cell → Divide in 90 min ⇒ cell cycle time
  - (b) Human cell → time of cell cycle → 24 hr (in medium/culture)
    - M-phase – 1 hr ✓
    - G_1 → 8–12 hr
    - S → 6–8 hr
    - G_2 → 3–4 hr

] Interphase

note – Cell cycle time is variable for two Different type of cell

Acc. to time → $G_1 > S > G_2 > M$ (Shortest)

(G_1 phase → variation – depend on Nutrients from outside)

So Maximum Variation

cell theory

MANTHAN NEET 2025

Cell cycle and cell division

lecture - 2

Botany

TARUN SIR

Topics

Basics of cell cycle

Mitosis

Meiosis

Questions

number of Question = 4-5

level → Easy to medium

Today's Goal

Cell Cycle - detail

Amount of DNA, Ploidy

cell theory

10.1.1 Phases of Cell Cycle

A typical eukaryotic cell cycle is illustrated by human cells in culture. These cells divide once in approximately every 24 hours (Figure 10.1). However, this duration of cell cycle can vary from organism to organism and also from cell type to cell type. Yeast for example, can progress through the cell cycle in only about 90 minutes.

The cell cycle is divided into two basic phases:

- **Interphase**
- **M Phase (Mitosis phase)**

The M Phase represents the phase when the actual cell division or mitosis occurs and the interphase represents the phase between two successive M phases. It is significant to note that in the 24 hour average duration of cell cycle of a human cell, cell division proper lasts for only about an hour. The interphase lasts more than 95% of the duration of cell cycle.

Figu

The M Phase starts with the nuclear division corresponding to the separation of daughter chromosomes **(karyokinesis)** and usually ends with division of cytoplasm **(cytokinesis)**. The interphase, though called the resting phase is the time during which the cell is preparing for division by undergoing both cell growth and DNA replication in an orderly manner. The interphase is divided into three further phases:

- **G_1 phase (Gap 1)**
- **S phase (Synthesis)**
- **G_2 phase (Gap 2)**

G_1 phase corresponds to the interval between mitosis and initiation of DNA replication. During G_1 phase the cell is metabolically active and continuously grows but does not replicate its DNA. S or **synthesis** phase marks the period during which DNA synthesis or replication takes place. During this time the amount of DNA per cell doubles. If the initial amount of DNA is denoted as 2C then it increases to 4C. However, there is no increase in the chromosome number; if the cell had diploid or 2n number of chromosomes at G_1, even after S phase the number of chromosomes remains the same, i.e., 2n.

In animal cells, during the S phase, DNA replication begins in the nucleus, and the centriole duplicates in the cytoplasm. During the G_2 phase, proteins are synthesised in preparation for mitosis while cell growth continues.

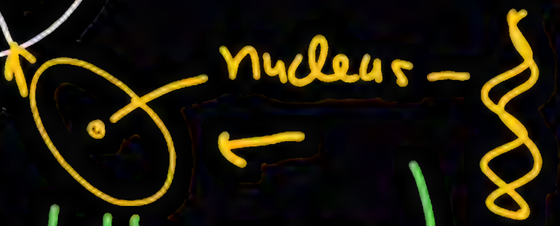
Changes

G_1 phase

- Gap B/w M & S phase

- Cell Growth occur
- Growth Require nutrients as well as Enzymes

(For Enzyme Synthesis → Transcription & translation occur)



Cell is Metabolically Active

- G_1 phase – DNA Damage Repair (Damage DNA should not Enter into S-phase)

Check point → G_1/S → Untill all Requirement of G_1 phase not completed
Cell not Enter into S-phase

- Some organelle like ER & Golgi bodies – Synthesis occur

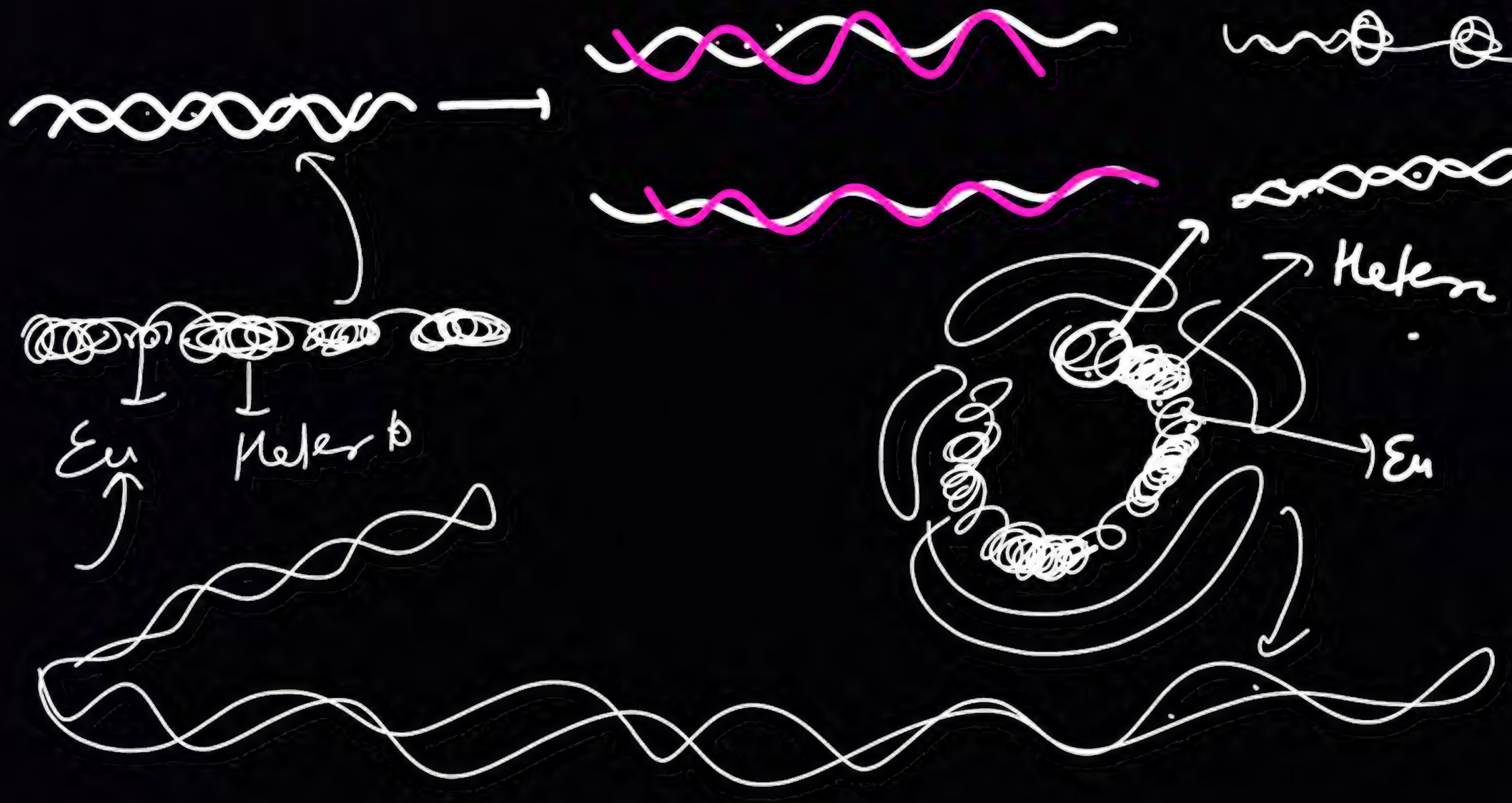
s phase — Synthetic phase

- DNA Replication occur → occur inside nucleus
  - Amount of DNA in G_1 phase = 2c
    - In S-phase → Amount get change (2c → 4c) to 4c

- Centriole (Animal cell) – Double in S-phase
  (two centriole = centrosome) in cytoplasm of Animal cell
- Histones also get Double in S-phase
- S-phase – Euchromatin get Double than Heterochromatin

Euchromatin (less condensed) → Heterochromatin (more condense)

S-phase


Helicase
En
Helicase
En

G_2 phase

– It is Gap B/w DNA Replication and cell Division

– Amount of DNA = 4C (cell in G_2 phase)

– Cell prepare itself → For cell Division

– tubulin protein (For spindle Fibre) Synthesis Require

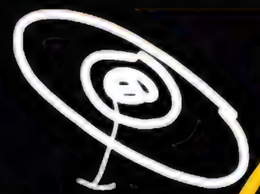
[– Some organelle – like mitochondria and Plastids get Double]

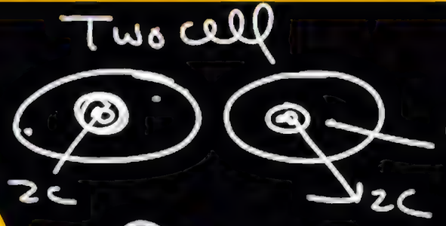
→ Cell Division

– Growth
– DNA Damage Repair
– Metabolically Active

→ DNA Replication
– Histone synthesis
– Centriole Doubt

Amount of DNA and ploidy — Diploid cell





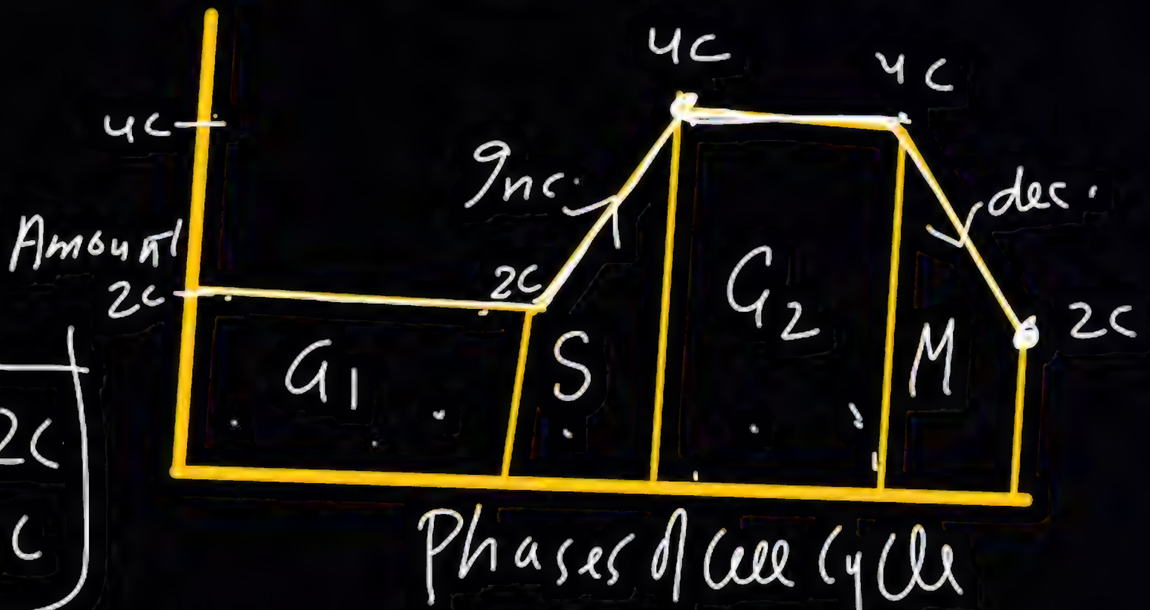
Inside nucleus = Chromatin
⇒ Amount = 2C

Q In which phase of cell cycle Amount of DNA is Changed

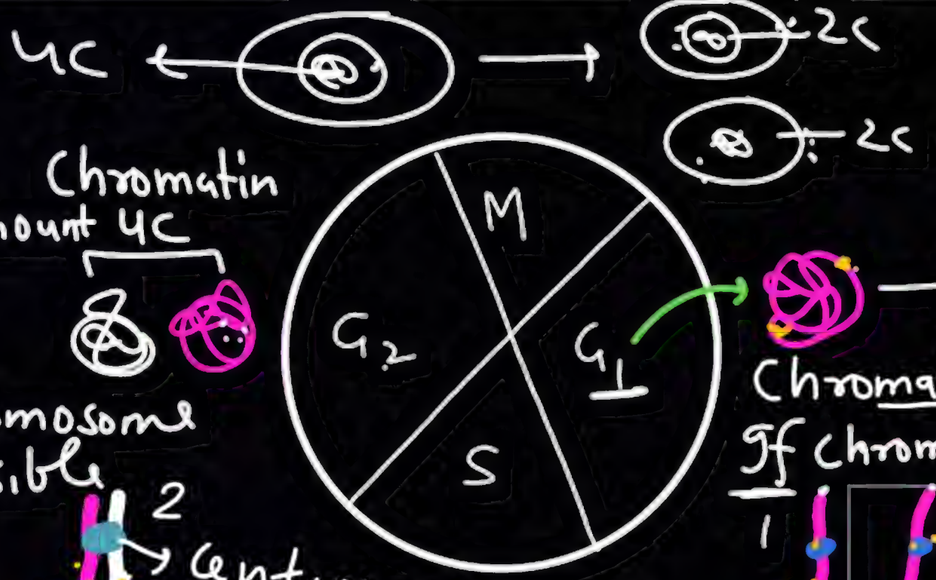
(a) G1 & S
(b) S & M
(c) G1 & G2
(d) None

Amount (2C → 4C) Change

Constant Amount = G1 = 2C
G2 = 4C



Ploidy change in cell cycle

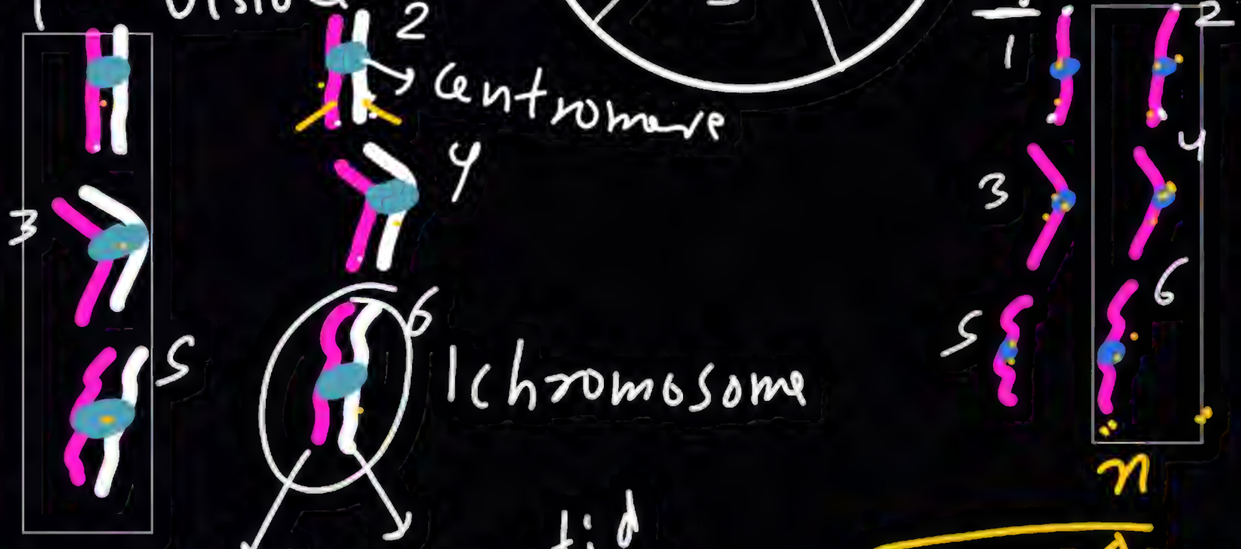


- Chromatin visible in - G_1, S, G_2
- Chromosome visible in - M-phase

Amount = 2C

Chromatin visible

If chromosome visible



2n=6

- In G_1 phase = 6 chromosome, 6 chromatid
- In G_2 phase = 6 chromosome, 12 chromatid

Chromatid → Sister chromatid

Human cell

	Amount of DNA	Chromosome	Chromatid	Centromere
G_1	2C	46	46	46
G_2	4C	46	92	46

Amount = 4C

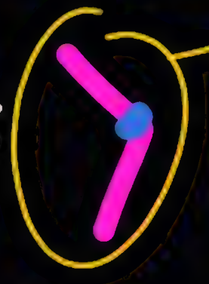
2C - Amount

Chromosome = 46

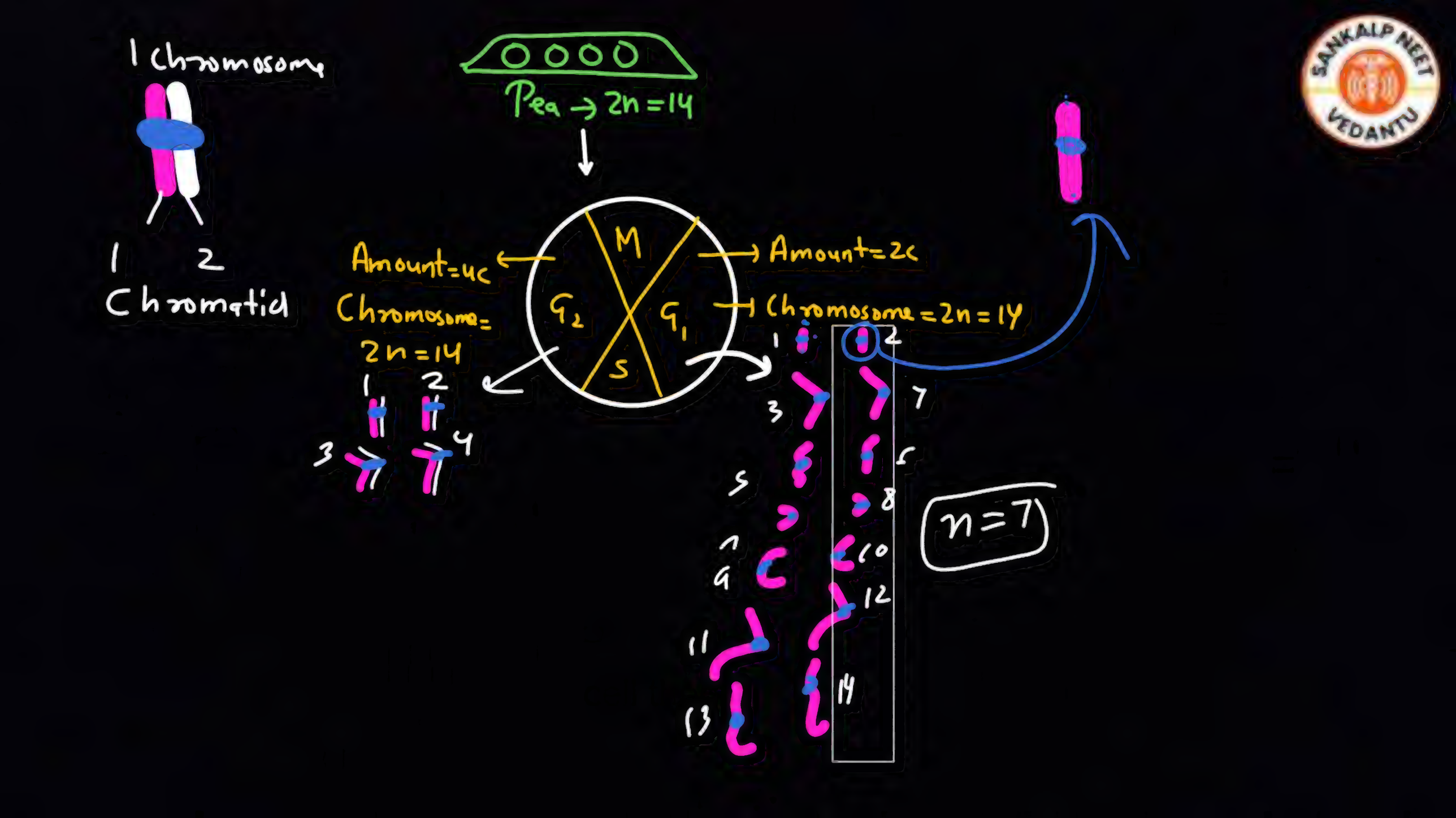
Chromosome = 46

Chromosome = 2 Chromatid

Chromatid



Chromosome = Chromatid


1 Chromosome
1
2
Chromatid
Pea → 2n = 14
M
G2
G1
S
Amount = 4c
Chromosome = 2n = 14
Amount = 2c
Chromosome = 2n = 14
n = 7
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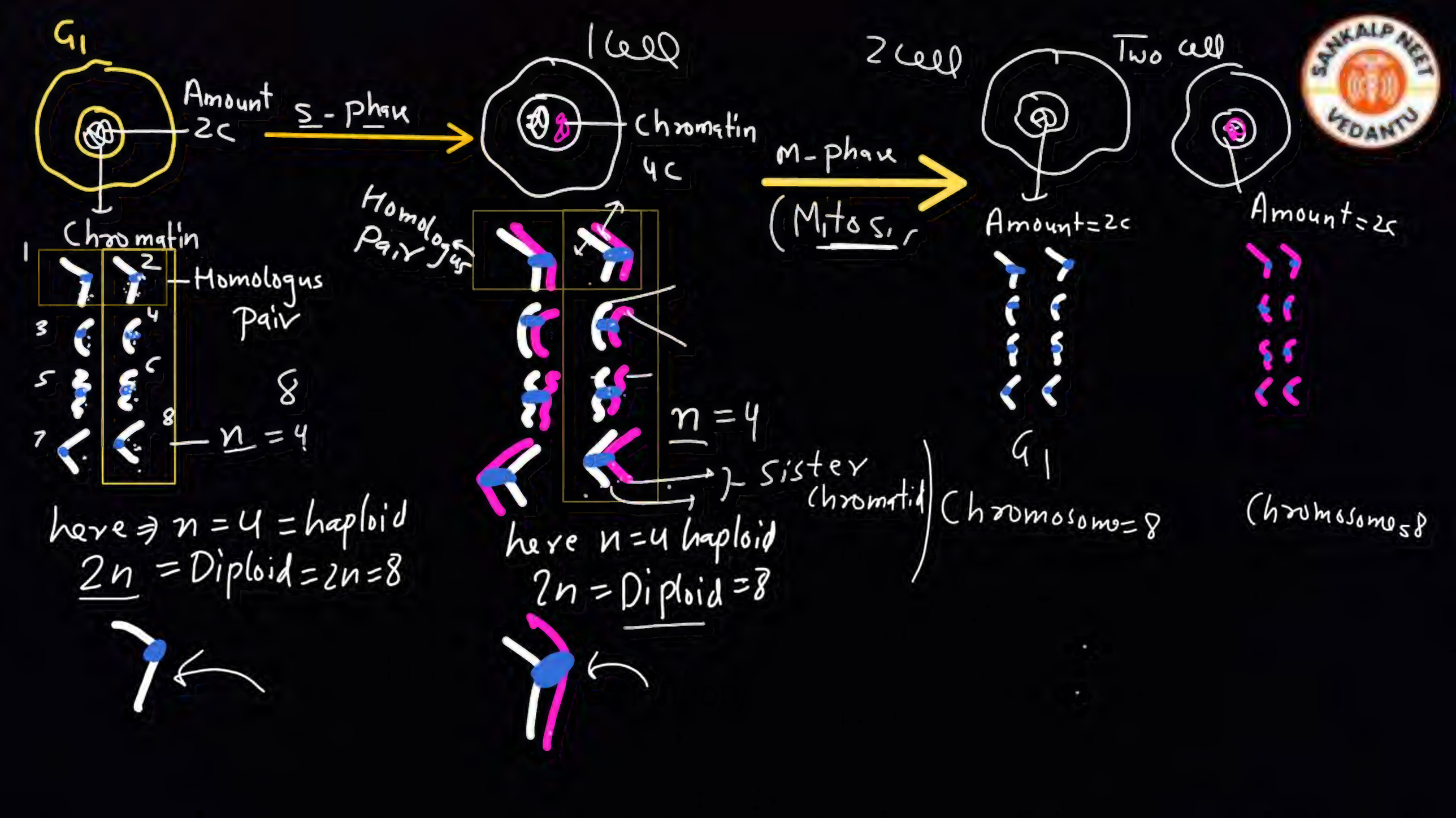
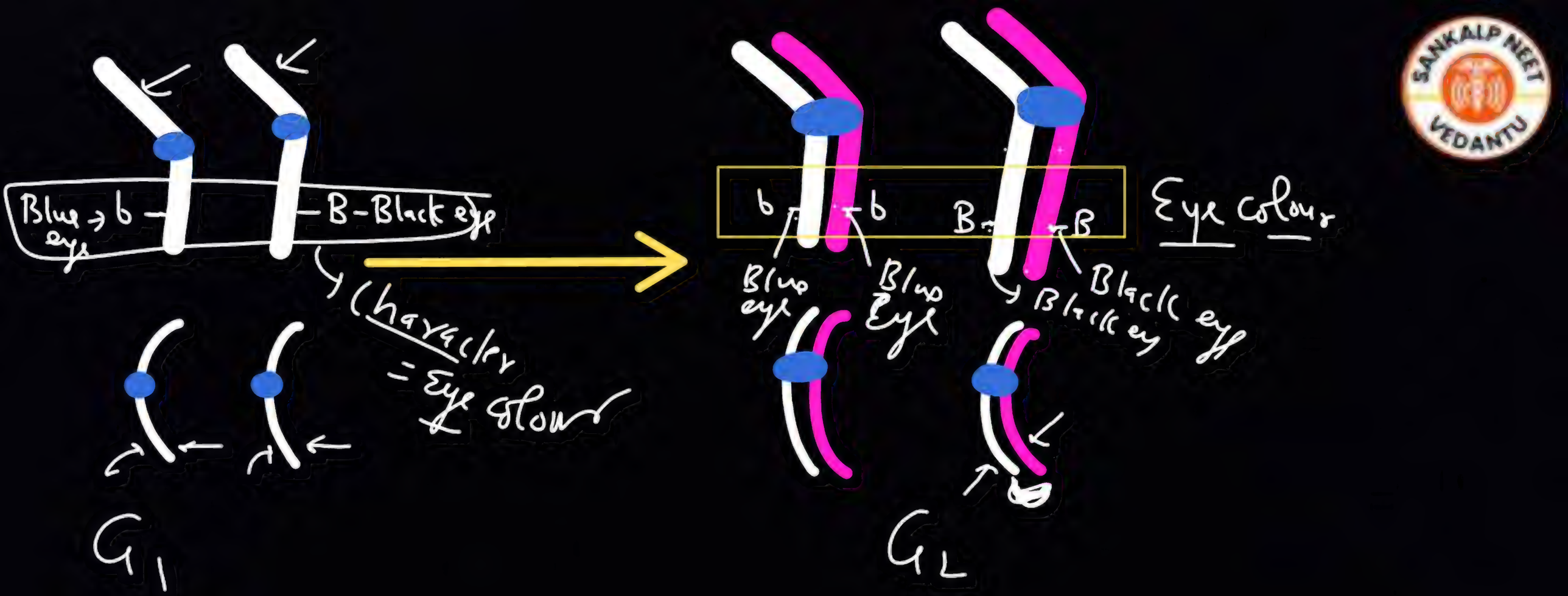
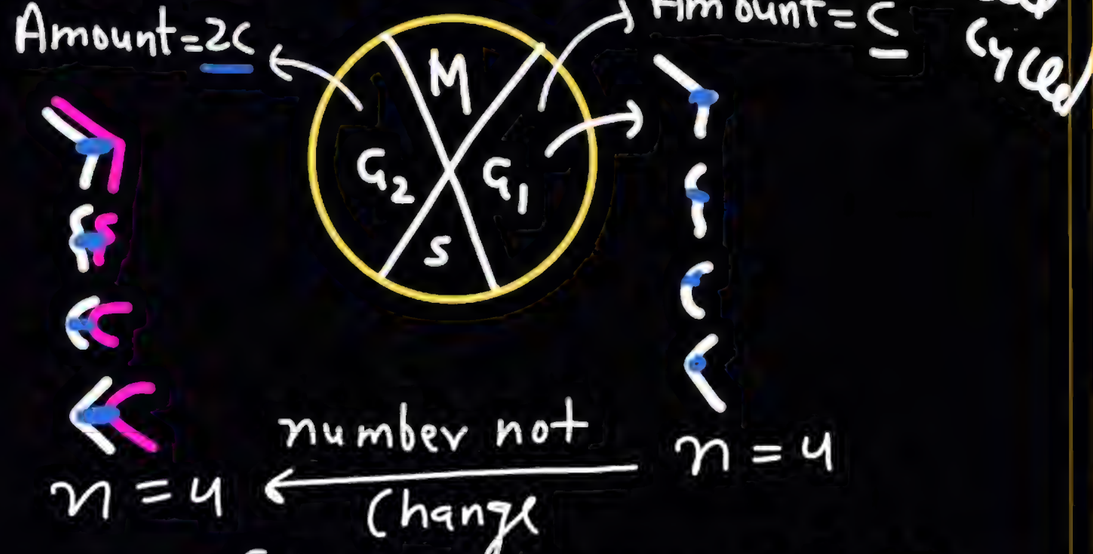

G1
Amount
2c
S-phase
1 cell
8
Chromatin
4c
2 cell
M-phase
(Mitosis)
Two cell
Amount=2c
Amount=2c
Chromatin
1
2
3
4
5
6
7
8
Homologus Pair
8
n=4
Homologus Pair
n=4
Sister Chromatid
here ⇒ n=4 = haploid
2n = Diploid = 2n=8
here n=4 haploid
2n = Diploid =8
G1
Chromosome=8
Chromosome=8
SANKALP NEET
VEDANTU


Blue → b
eye
B - Black eye
Character
= Eye colour
G1
b
b
B
B
Eye colour
Blue eye
Blue Eye
Black eye
Black eye
G2

Haploid cell – Lila Algae (Yes show cell cycle)

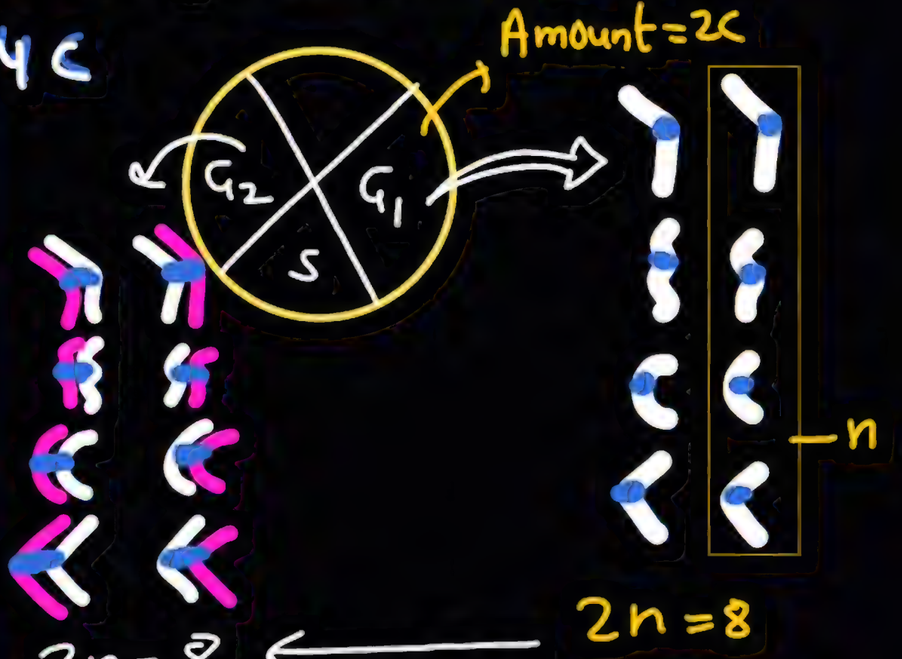


number not Change

(Amount change → C to 2C

– haploid cell Amount → C to 2C

Diploid cell



– no change in number

– only Amount change

– Diploid cell Amount Vary → 2C → 4C

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Q In a Algae cell (G_1 / haploid) ($n=7$), number of chromosome in (G_2 phase) & Amount of DNA

(a) 7, 4c (b) 7, 2c (c) 14, 4c (d) none

Cell – haploid

$G_1 = n=7 \longrightarrow c$

$G_2 \rightarrow n=7 \longrightarrow 2c$

Q In a leaf cell ($2n=18$) chromosome, Same plants Root cell have chromosome in G_2 phase

(a) 36 (b) 9 (c) 18 (d) none

$G_1 = 18$

$G_2 = 18$

[Gametes = haploid]

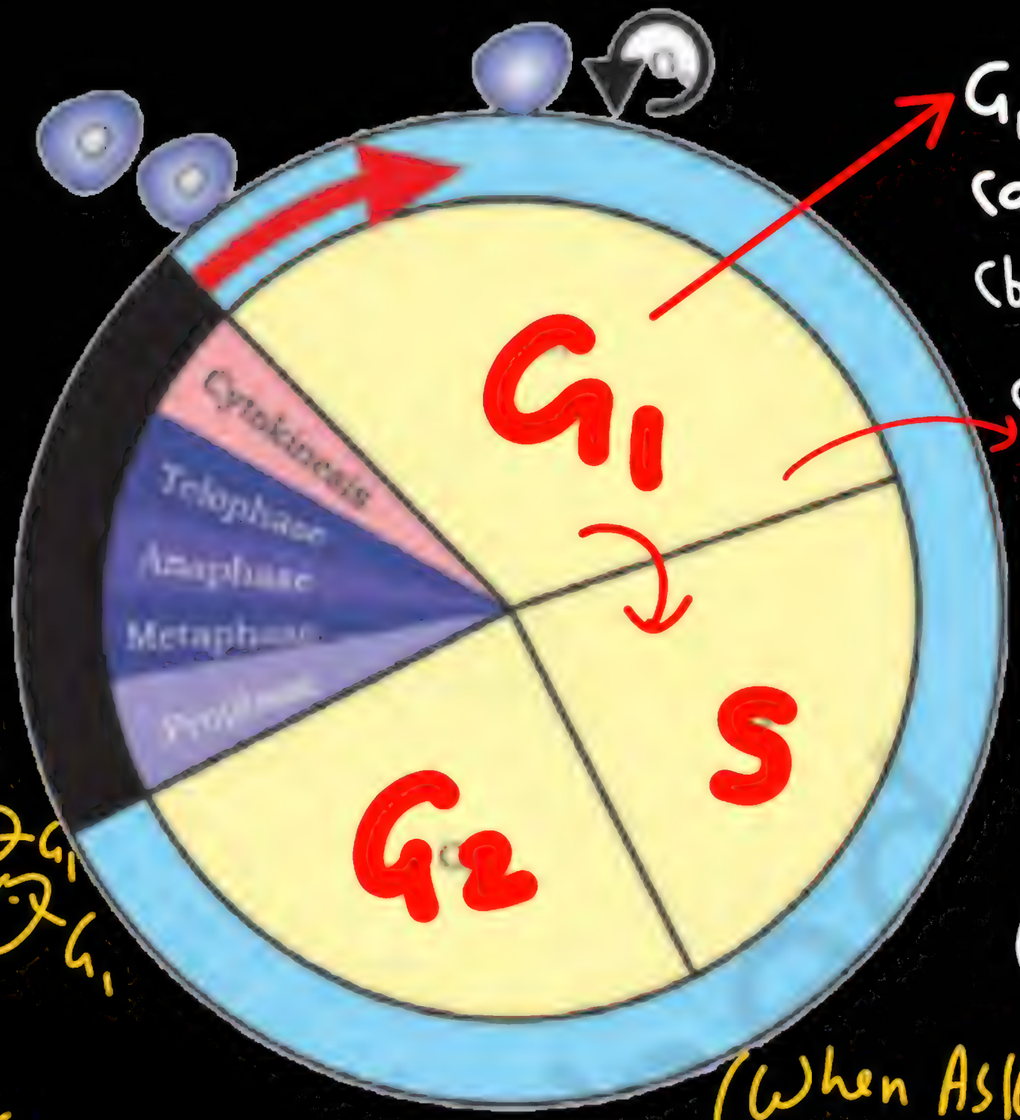
Q In a Rice plant cell in G_2 phase have 40 chromosome ($2n=40$)

no. of chromosome in Egg cell = n

(a) 10 (b) 20 (c) 30 (d) 40

$2n=40 \longrightarrow G_1$

$G_2 = 2n=40$

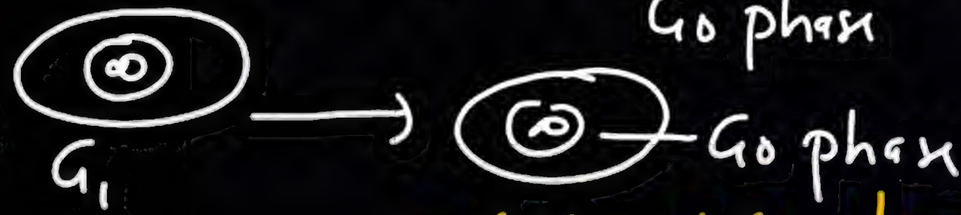


G_1 phase cell → options Available

(a) Enter into S-phase → cell has to Divide

(b) Cell Become permanent → Role Fix → Finally cell death

(c) Exit cell cycle → Enter into G_0 phase



- Cell Not Grow / Not Proliferate
- Cell not Divide

(Enzyme Activity But cell is living

- G_0 phase - quiescent phase

(When Asked to come back → Enter into G_1 phase

DOPA-01

Q1 DNA Replication start in Yeast
(a) S-phase (b) G_1-phase (c) G_2 phase (d) M-phase

Q2 Occur in Cytoplasm in S-phase
(a) Centriole double (c) DNA Double (c) nucleolus visible (d) none

Q3 Cell is Enter into Quisant phase means
(a) not Divide (b) Metabolically Very Active (c) no Enzyme Activity (d) all

Q4 Amount of DNA is constant in
(a) G_1 (b) G_2 (c) M (d) S

Q5 Amount of DNA in haploid cell in G_1
(a) C (b) 2C (c) 4C (d) 3C

Q6 Amount of DNA in Diploid cell in G_2

(a) 2c (b) 4c (c) 3c (d) 4c

Q7 Number of chromatid in cell ($2n=16$) in G_1 phase

(a) 16 (b) 8 (c) 32 (d) 48

Q8 Number of chromatid in cell ($2n=18$) in G_2 phase

(b) 36 (b) 18 (c) 9 (d) all

Q9 Which Have same genes

(a) 3rd & 4th chromosome (b) two chromosome of Homologous pair (c) Sister chromatid (d) all

Q10 Sister chromatids are Double to number of centromere in

(a) G_1 (b) S (b) G_2 (d) none

(a) only S-I correct (b) Both S-I & S-II Correct (c) S-II correct (d) Both wrong

Q11 S-II DNA Replication occur in S-phase in E.coli
S-I DNA Replication occur in G_2-phase in Yeast

Q12 S-I Amount of DNA not change in M-phase
S-II Chromosome number get change in G_2 phase

Q13 S-I haploid cell Amount of DNA 2C in G_2 phase
S-II Diploid cell Amount of DNA 4C in G_2 phase

Q14 S-I Number of Chromosome is 1/4 to the number of cell in G_2 in Gametes
S-II Number of Chromosome is 1/2 to the number of cell in G_2 in Egg

Q15 S-I G_0 phase not show proliferation
S-II Cell not come back from G_1 to G_0 Even if Require

MANTHAN NEET 2025

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Cell cycle and cell division

lecture - 3

Botany

TARUN SIR

Topics

Basics of cell cycle

Mitosis

Meiosis

Questions

number of Question = 4-5

level → Easy to medium

cell theory

Today's Goal

Mitosis

Last class Revision

Phase	G_1	S	G_2	M
time (least - 90min, Human cell 24hr)	8-12	6-8 (95%)	3-4	1hr (5%)
Change	— Growth - Metabolically Acting - Damage Repair	DNA Replication = centriole double (Amount Inc. Histone)	Preparation (tubulin)	Cell Divide
Amount	2C	2C → 4C	4C	4C ⇌ 2C + 2C
number	not change			

G_0 → Not Growth, cell living

Exit G_1 phase → G_0 phase

Mitosis – occur in – haploid cell and Diploid cell

Plants

Animals

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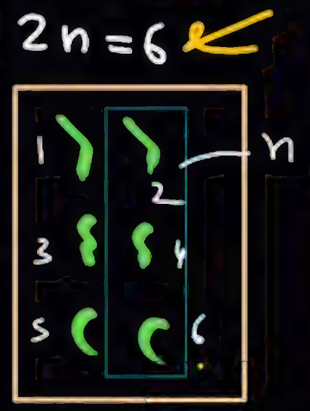
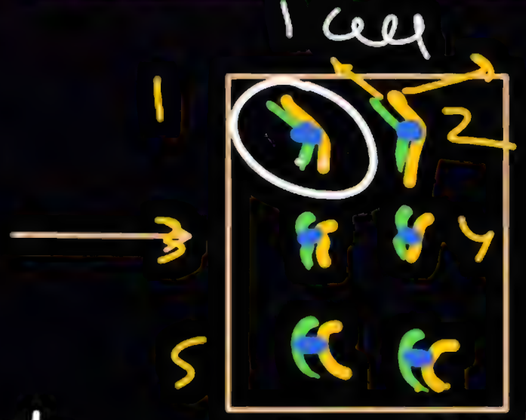
Basics of Mitosis



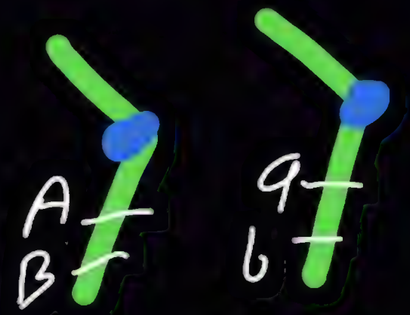
G_1 Parent cell



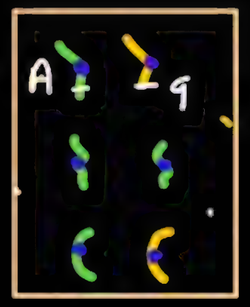
G_2 2n=6

Chromosome

1 chromosome = 2 sister chromatid



M-phase (Mitosis)



2n=6

2n=6

(Progeny)

] Two Daughter cell
– Genetically identical

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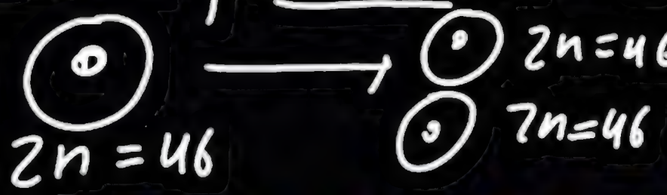
M phase — Mitosis – cell Actually Divide

Feature – It is most Dramatic phase → Drama → Big changes occur in – Cytoplasm & nucleus

→ Complete Reorganization of all component of nucleus & cell (Cytoplasm & nucleus)

→ Daughter cell & parent cell – Chromosome number same



→ Equational Division

Assertion – Mitosis is Equational Division ✓

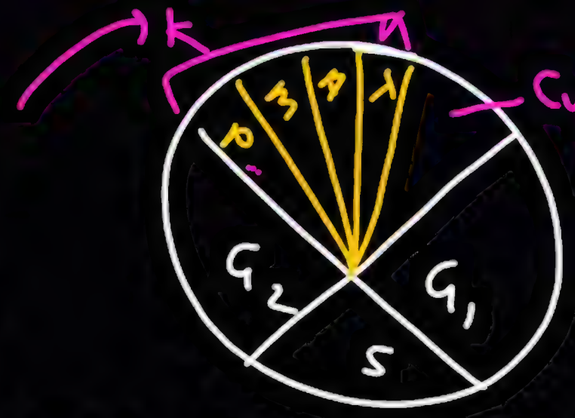
Reason → No. of chromosome in Parent cell & Daughter cell same

10.2 M PHASE

This is the most dramatic period of the cell cycle, involving a major reorganisation of virtually all components of the cell. Since the number of chromosomes in the parent and progeny cells is the same, it is also called as ***equational division.*** Though for convenience mitosis has been divided into four stages of nuclear division (karyokinesis), it is very essential to understand that cell division is a progressive process and very clear-cut lines cannot be drawn between various stages. Karyokinesis involves following four stages:

- ***Prophase***
- ***Metaphase***
- ***Anaphase***
- ***Telophase***

M-phase



① Karyokinesis (Nuclear Division)

1. Prophase
2. Metaphase
3. Anaphase
4. Telophase

② Cytokinesis (Cytoplasm Divide)

* S-I → Prophase is First phase of Mitosis ✓
  S-II - Cytokinesis is last phase of Karyokinesis ✗

Time → Prophase > Telophase > Metaphase > Anaphase → Shortest

→ M-phase Divided into Karyokinesis & cytokinesis
→ Karyokinesis is further Divided into Four Phase (PMAT)
→ Cell Division is a countinuous process → phases are Basically Changes

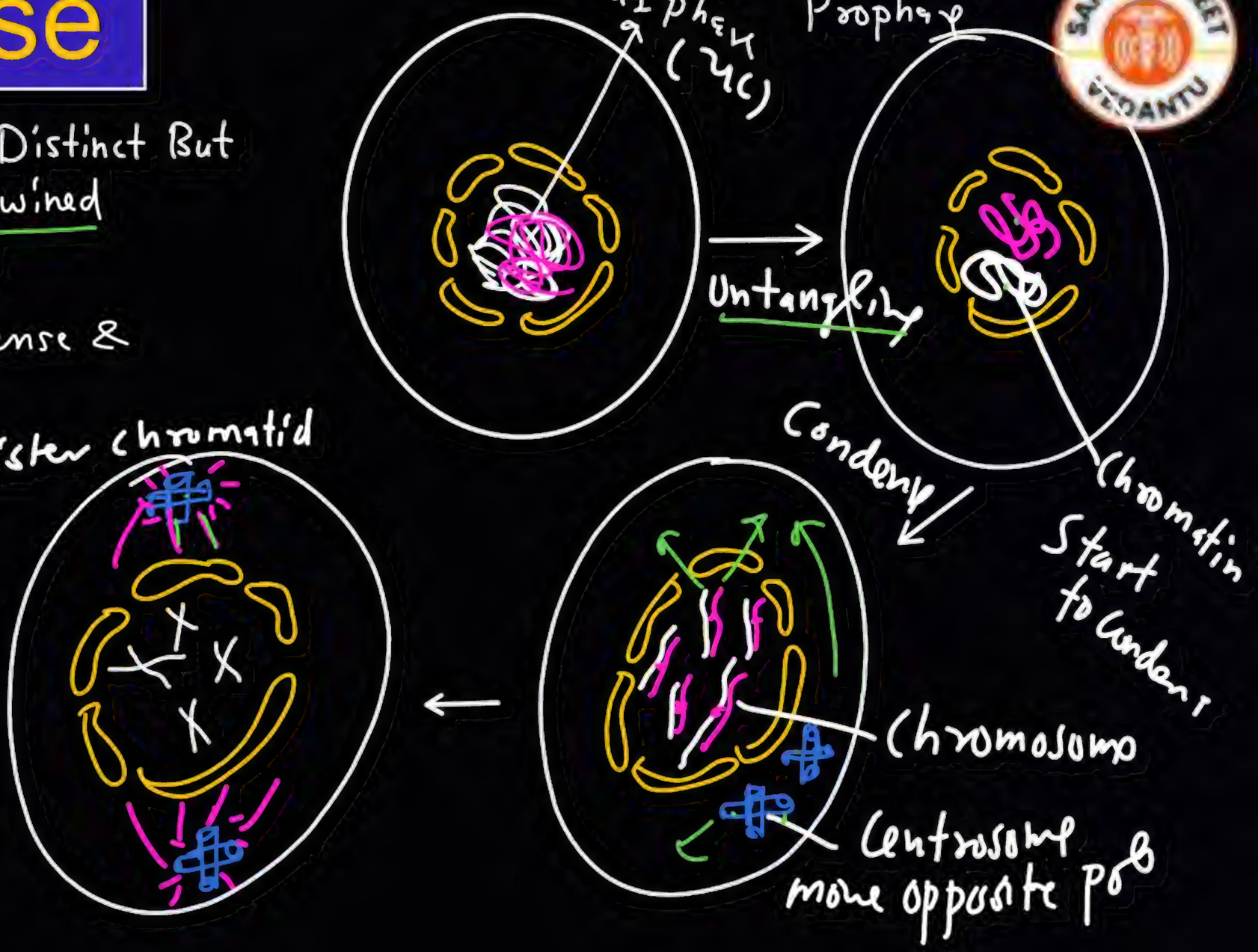
Mitosis study in – Onion tip

Prophase

G2 phase
(Chromatin)
↓
(Interwined)
↓
Untangling
↙
Condense to Form
Chromatino

Prophase

* Chromatin in G_2 phase → not Distinct But interwined
* Untangling of chromatin →
* Chromatin start to condense & Chromosome Form
* Chromosome – with two sister chromatid Appear
* Centrosome move to opposite pole



Changes in prophase

1. Chromatin (interwined) G_2 phase ⟶ Untangling ⟶ condensation of Chromatin ⟶ Chromosome with two sister chromatid

(Chromosomal material)

2. Centrosome move to opposite pole → protein use From Cytoplasm ⟶ Spindle Fibre From

3. Nuclear membrane not Disintegrate – Completely

4. Microscope → ER, Golgi body & nucleolus not Appear]

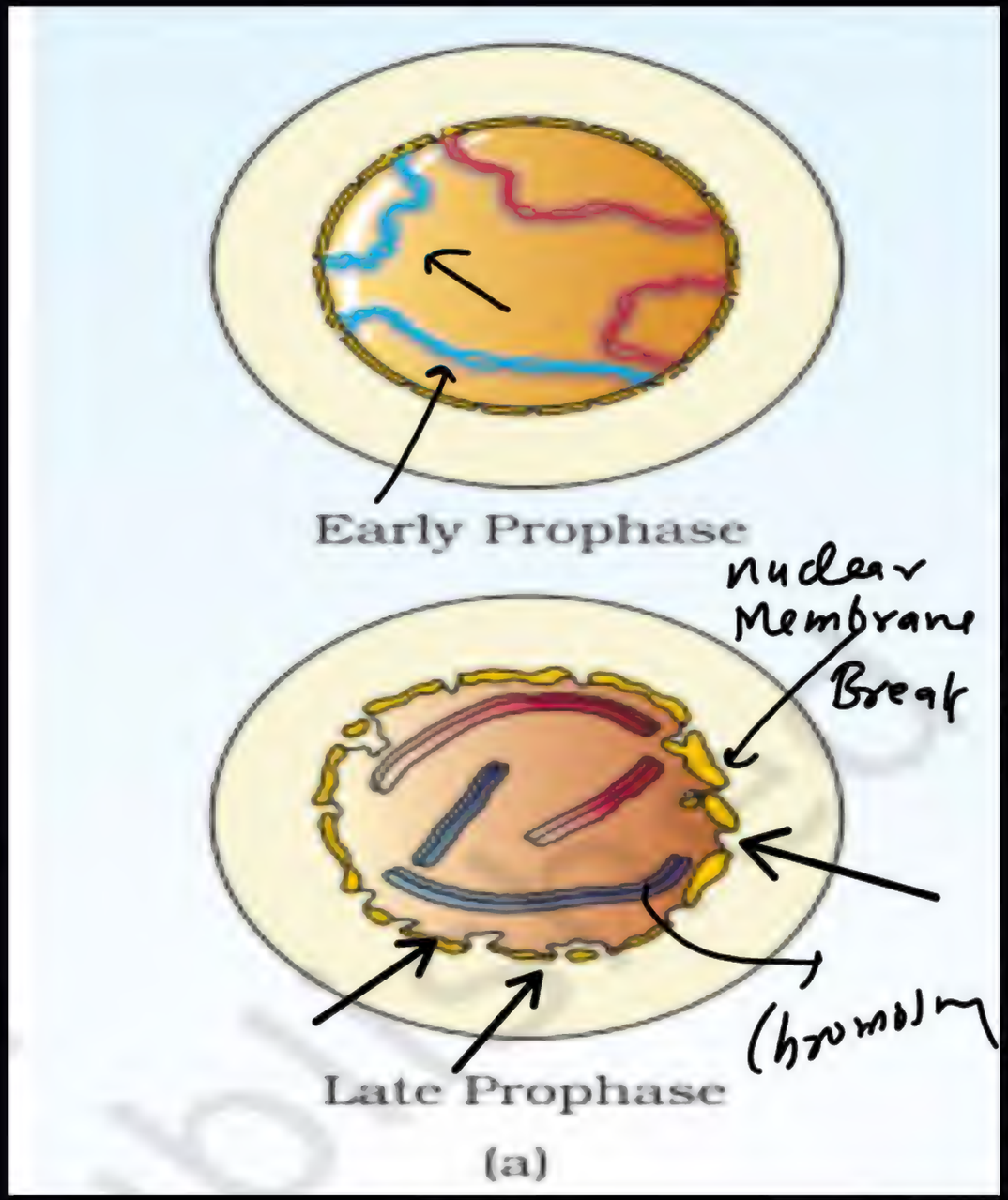
note – Chromosome is with two chromatid is visible (But not Fully condensed)
– nuclear membrane not Disintegrate completely

10.2.1 Prophase

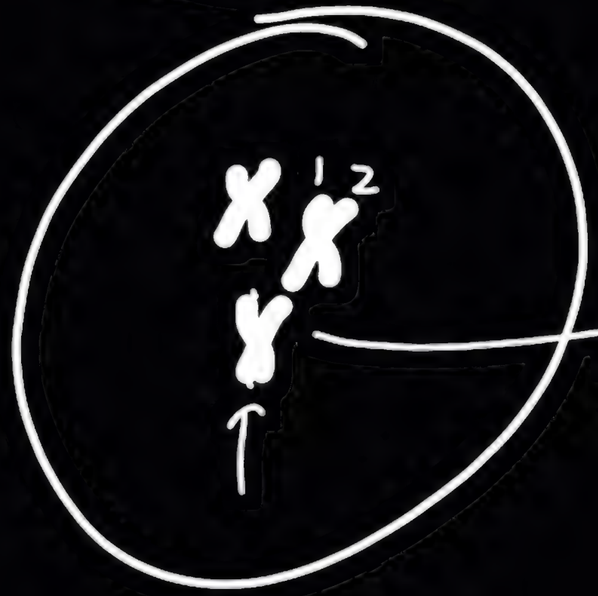
Prophase which is the first stage of karyokinesis of mitosis follows the S and G_2 phases of interphase. In the S and G_2 phases the new DNA molecules formed are not distinct but intertwined. Prophase is marked by the initiation of condensation of chromosomal material. The chromosomal material becomes untangled during the process of chromatin condensation (Figure 10.2 a). The centrosome, which had undergone duplication during S phase of interphase, now begins to move towards opposite poles of the cell. The completion of prophase can thus be marked by the following characteristic events:

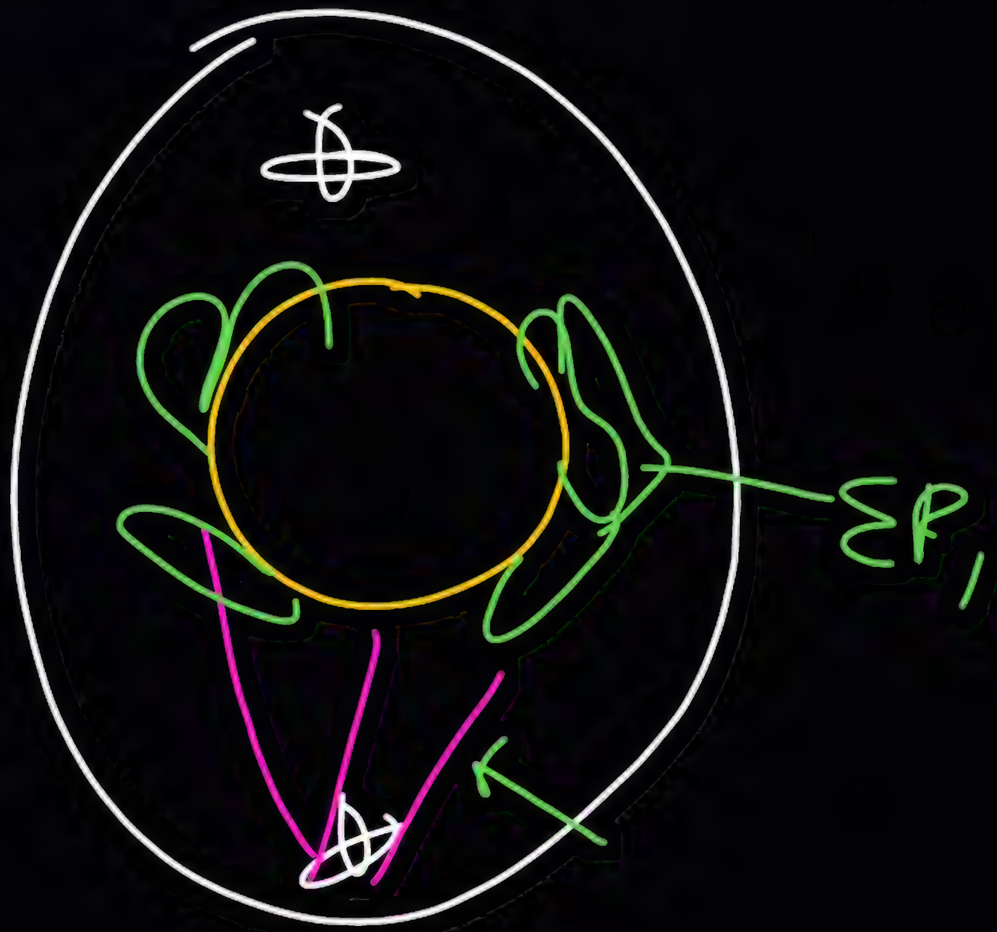
- Chromosomal material condenses to form compact mitotic chromosomes. Chromosomes are seen to be composed of two chromatids attached together at the centromere.
- Centrosome which had undergone duplication during interphase, begins to move towards opposite poles of the cell. Each centrosome radiates out microtubules called asters. The two asters together with spindle fibres forms mitotic apparatus.

Cells at the end of prophase, when viewed under the microscope, do not show golgi complexes, endoplasmid reticulum, nucleolus and the nuclear envelope.


Early Prophase
Nuclear Membrane Break
Late Prophase
(a)

1
2
Prophase


1
2
Metaphase
More condens



(= Spindle Apparatus)

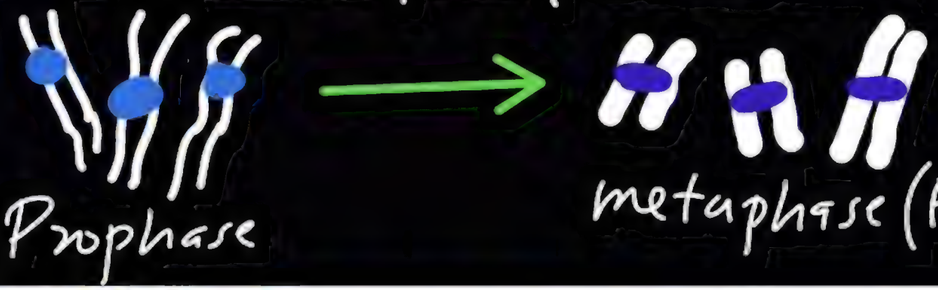
Metaphase

Last Event prophase – nuclear membrane start to Dis integrate

First Event → Complete Dis integration of nuclear membrane

(Chromosome come in cytoplasm)

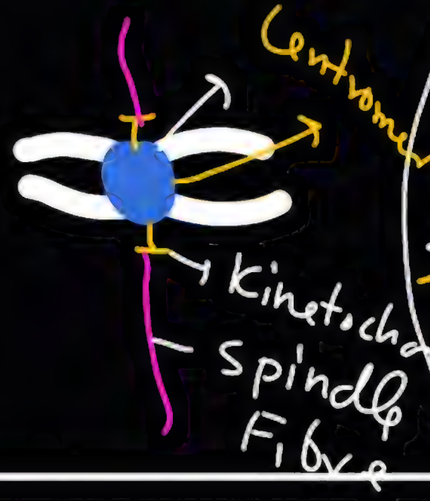
- Condensation of chromatin – start in prophase → two sister chromatid Chromosome visible
- Chromosome is fully condensed into metaphase

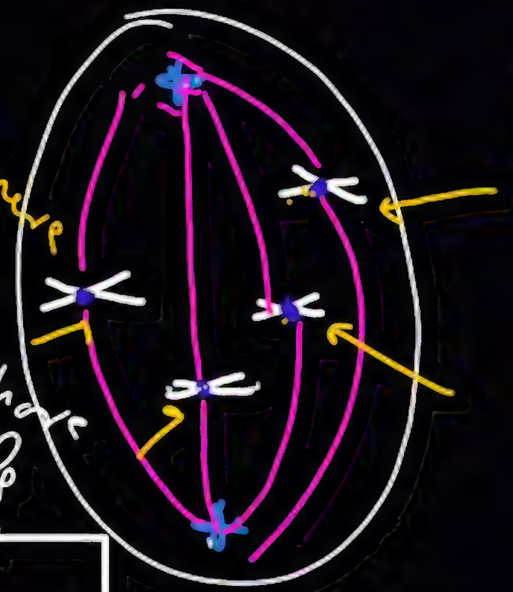


note – Metaphase is Best phase to observe Morphology & number

* Spindle Fibre get attach on chromosomy

(On centromere → Disc shape structure
Known as Kinetochore → on which
Spindle Fibre Attach)

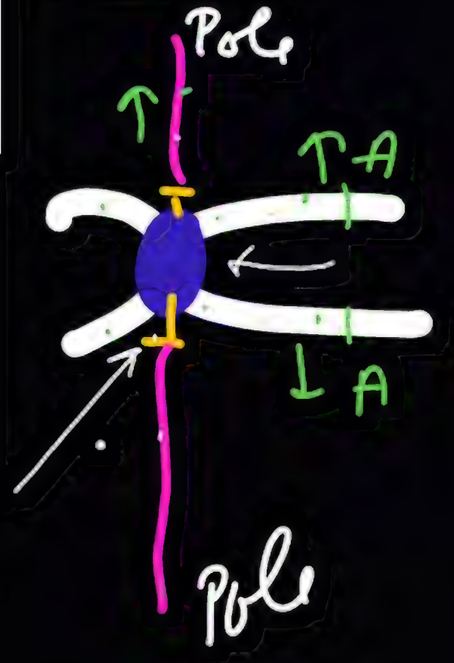




- One chromosome → Two spindle Fibre
  Attach → From opposite pole

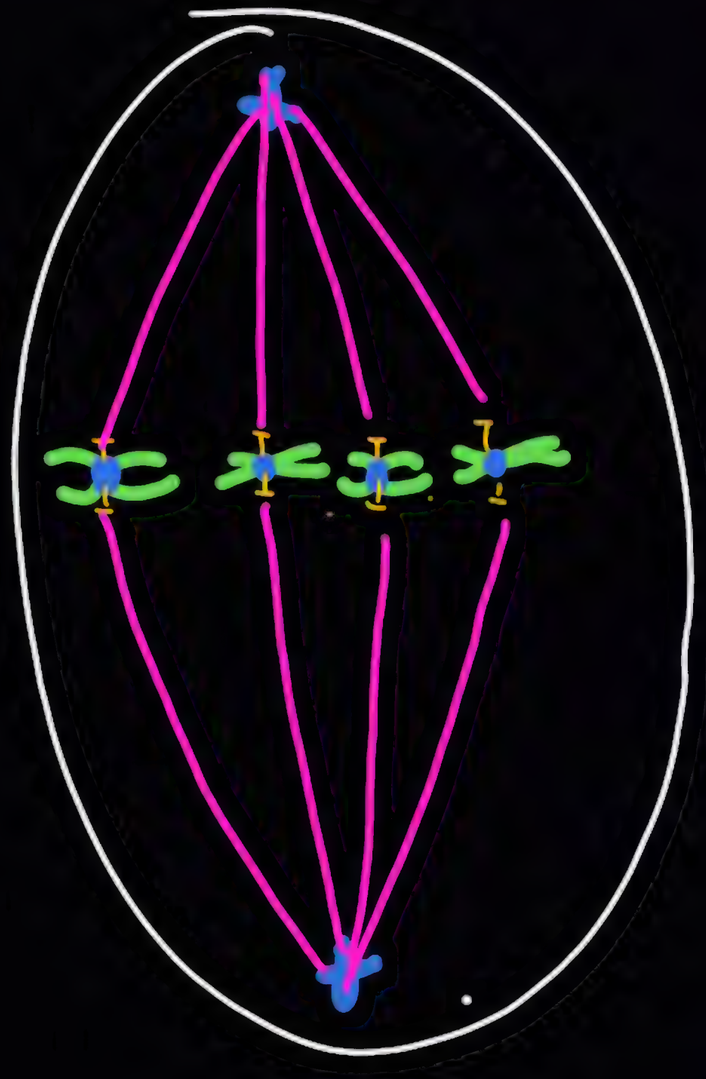
Human cell = 2n=46 → 92 Spindle Fibre

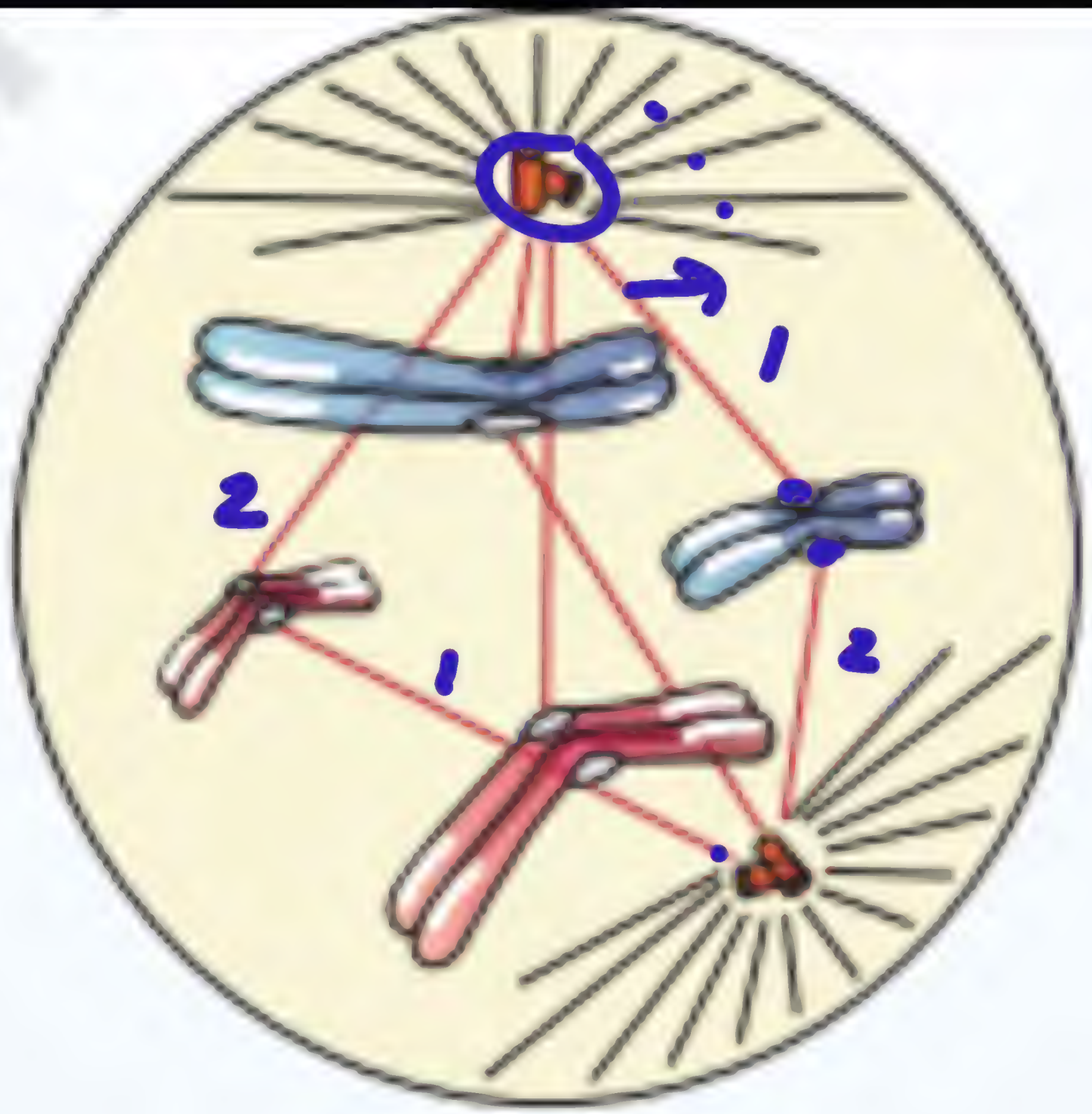
Pea plant ⇒ 2n=14 → 9n mitosis, metaphase = 28 spindle



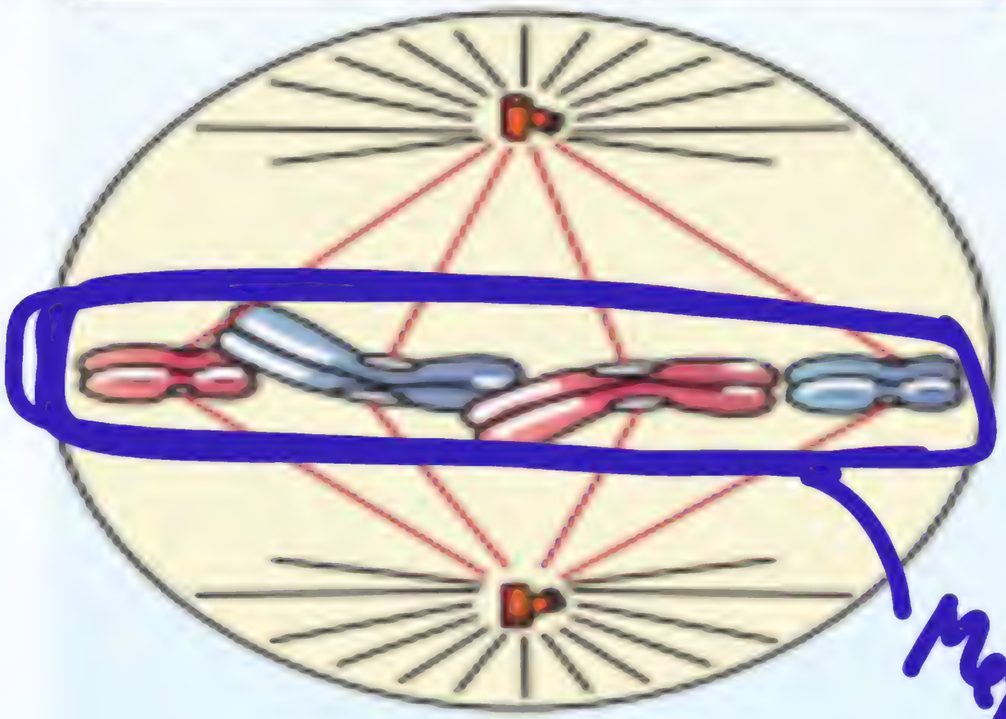
Last Event – all chromosome come at Equator of Spindle fibre ⟶

Plane of Alignment of chromusome at Equator is known as Metaphasic plate





Transition to Metaphase



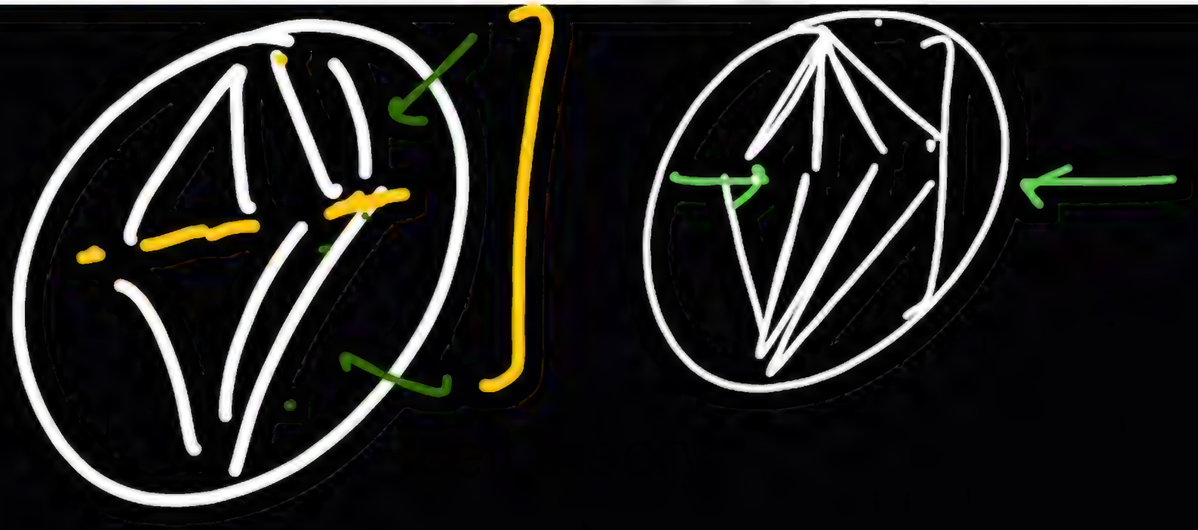
(b)

10.2.2 Metaphase

The complete disintegration of the nuclear envelope marks the start of the second phase of mitosis, hence the chromosomes are spread through the cytoplasm of the cell. By this stage, condensation of chromosomes is completed and they can be observed clearly under the microscope. This then, is the stage at which morphology of chromosomes is most easily studied. At this stage, metaphase chromosome is made up of two sister chromatids, which are held together by the centromere (Figure 10.2 b). Small disc-shaped structures at the surface of the centromeres are called kinetochores. These structures serve as the sites of attachment of spindle fibres (formed by the spindle fibres) to the chromosomes that are moved into position at the centre of the cell. Hence, the metaphase is characterised by all the chromosomes coming to lie at the equator with one chromatid of each chromosome connected by its kinetochore to spindle fibres from one pole and its sister chromatid connected by its kinetochore to spindle fibres from the opposite pole (Figure 10.2 b). The plane of alignment of the chromosomes at metaphase is referred to as the **metaphase plate.** The key

metaphase is referred to as the **metaphase plate.** The key features of metaphase are:

- Spindle fibres attach to kinetochores of chromosomes.
- Chromosomes are moved to spindle equator and get aligned along metaphase plate through spindle fibres to both poles.

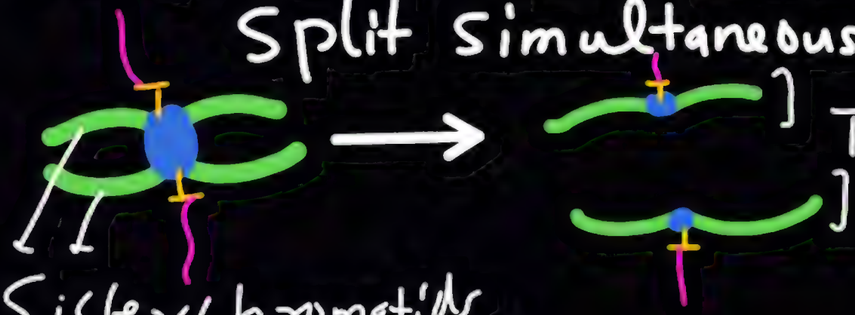


Anaphase

End of Metaphase – all chromosome at Metaphasic plate →

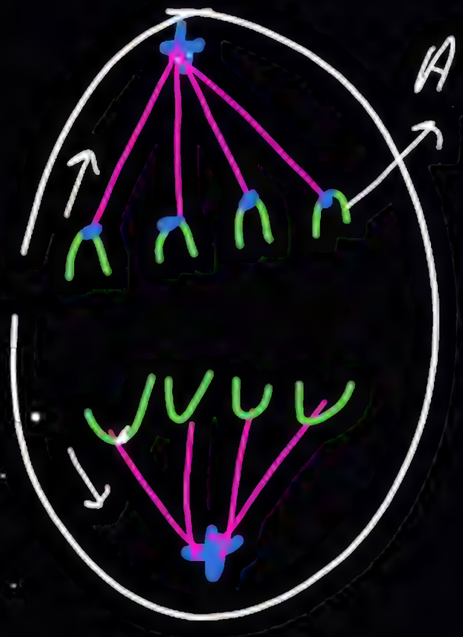
End of Metaphase

Anaphase → Sister chromatids of all chromosome Split simultaneously



Sister Chromatids

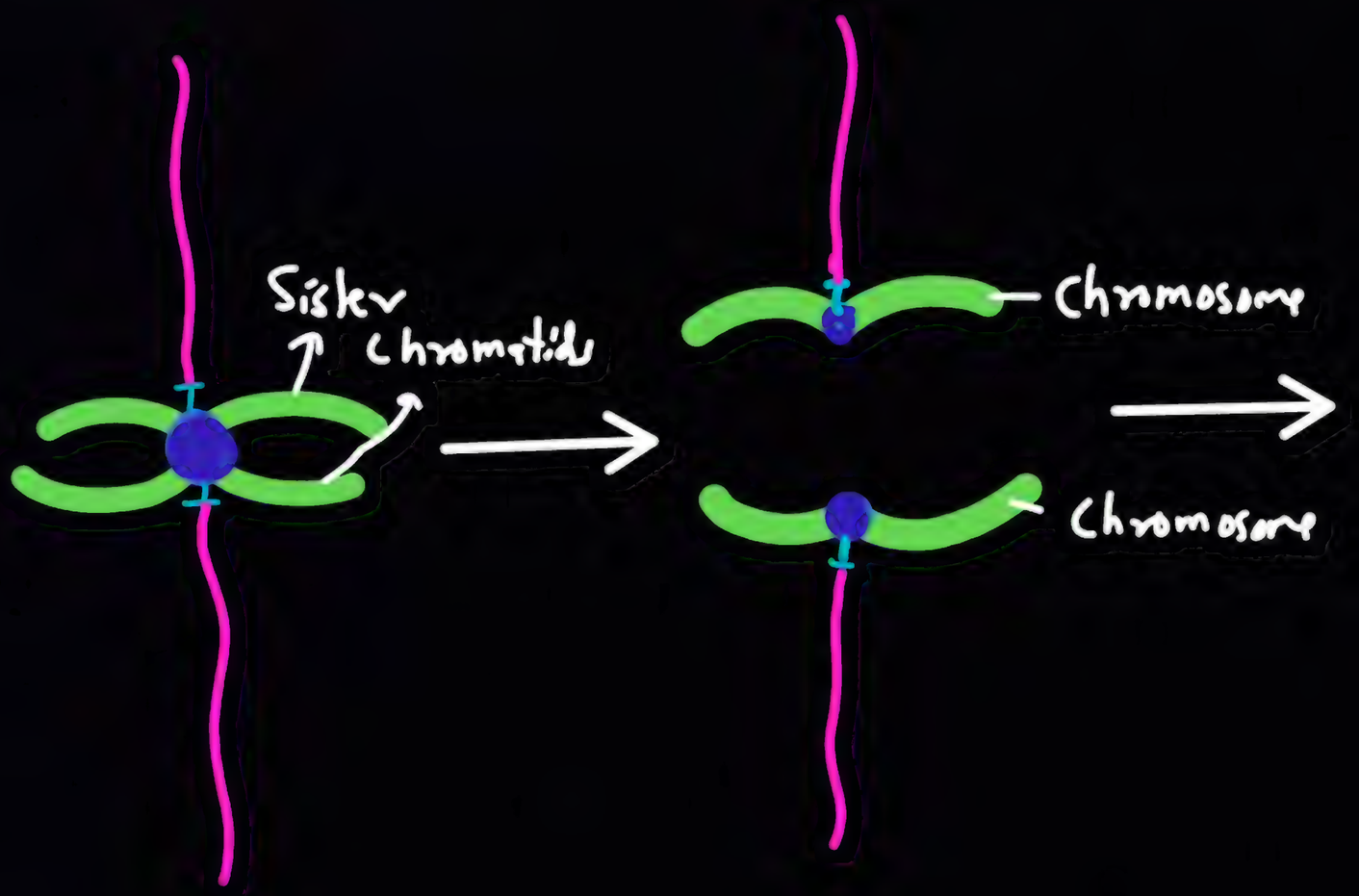
They are Chromosome of Future daughter nuclei

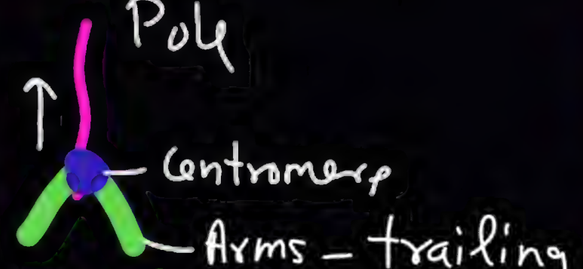


Arm

→ Daughter Chromosome move to opposite pole – with help of spindle Fibre

(Centromere projected towards pole and Arms trailing Behind)


Sister chromatids
Chromosome
Chromosome

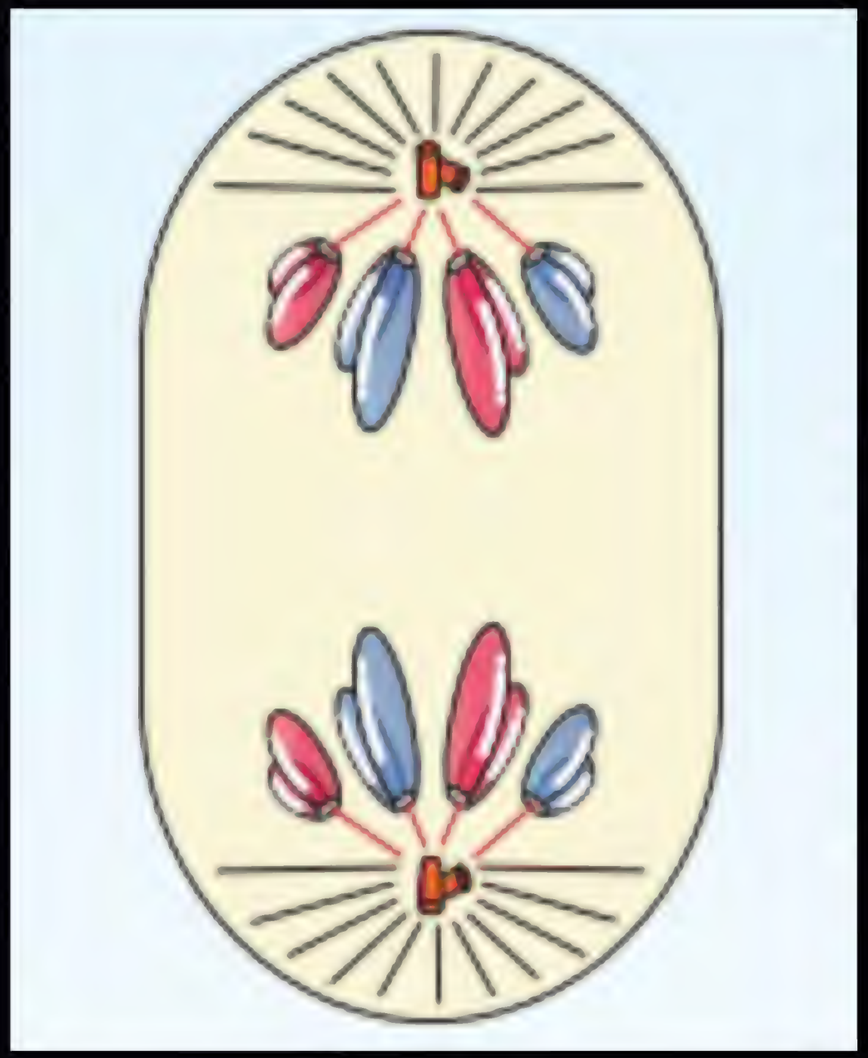

Pole
Centromere
Arms – trailing Behind

Pole

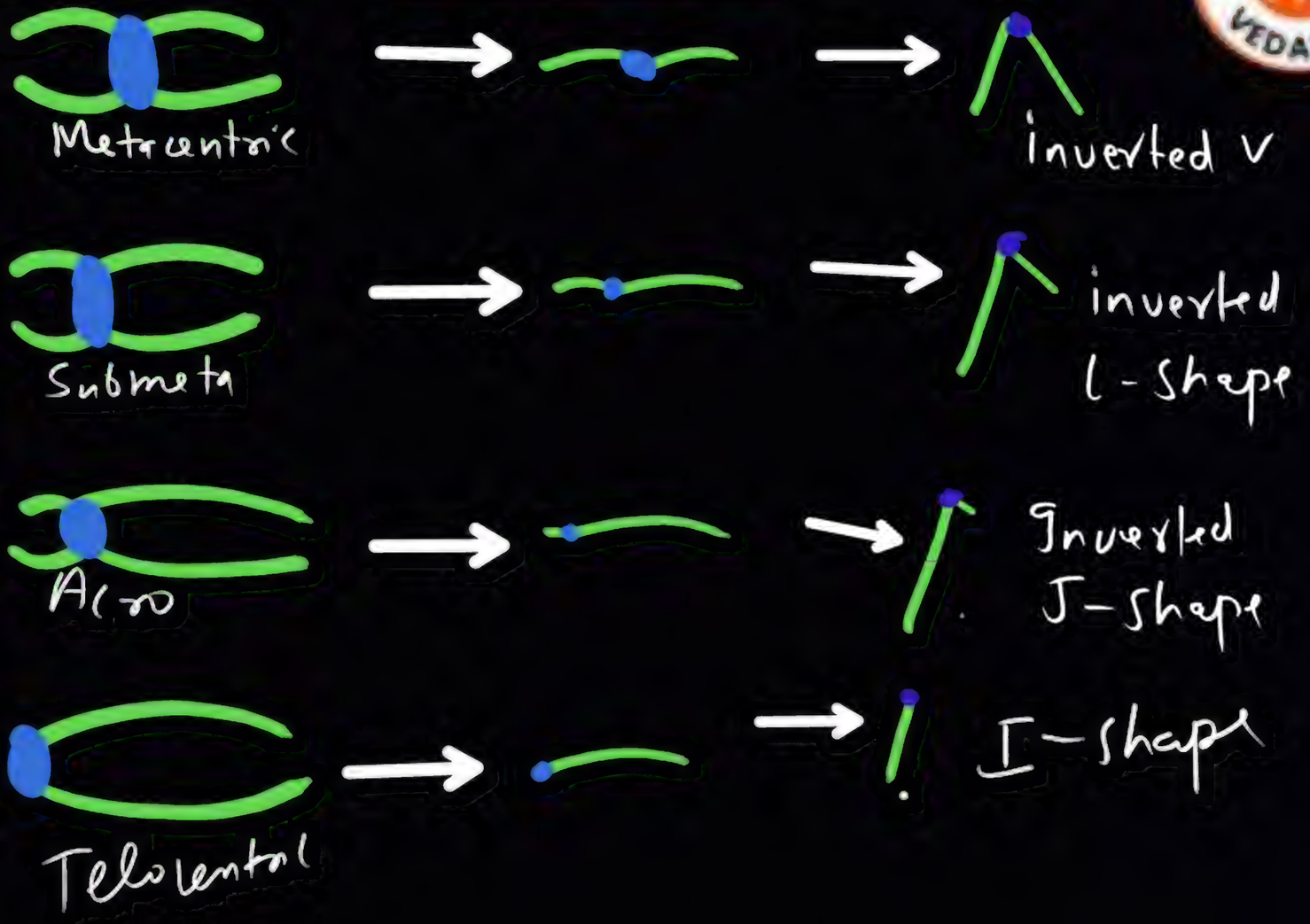
10.2.3 Anaphase

At the onset of anaphase, each chromosome arranged at the metaphase plate is split simultaneously and the two daughter chromatids, now referred to as daughter chromosomes of the future daughter nuclei, begin their migration towards the two opposite poles. As each chromosome moves away from the equatorial plate, the centromere of each chromosome remains directed towards the pole and hence at the leading edge, with the arms of the chromosome trailing behind (Figure 10.2 c). Thus, anaphase stage is characterised by the following key events:

- Centromeres split and chromatids separate.
- Chromatids move to opposite poles.



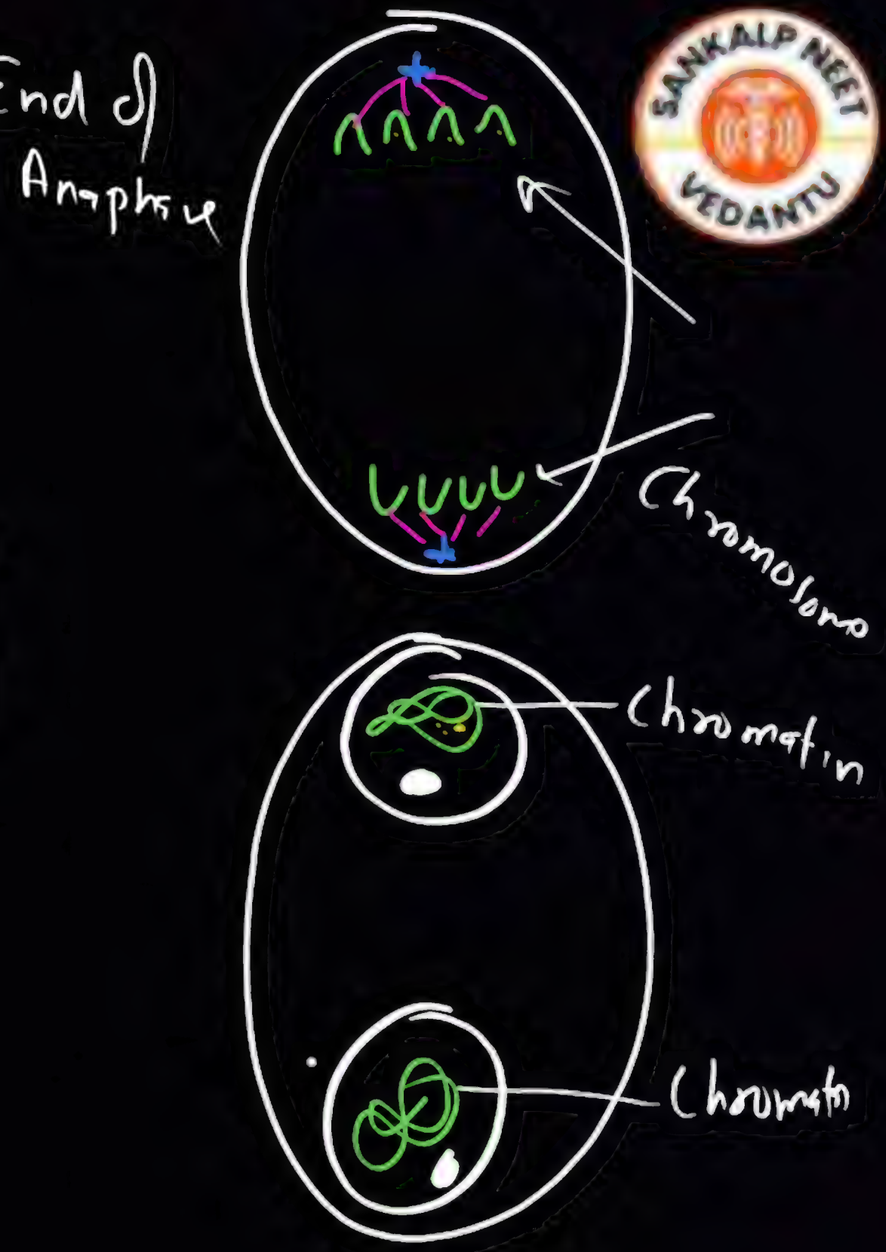
Shape - Anaphase



Telophase

- Chromosome at opposite pole
- Chromosome loose identity → and no more as Discrete Element
- nuclear membrane Form Again
- ER, golgi & nucleolus Reappear]

→ Two Daughter nuclei form



DOPA-02

Q1 Not true for M-phase
(a) Part of cell cycle (b) nuclear membrane Break (c) Chromosome in cytoplasm (d) DNA Inc.

Q2 Chromosome inside cytoplasm in
(a) Prophase (b) Metaphase (c) Anaphase (d) Telophase

Q3 Sister chromatids get separated in
(a) Cytokinesis (b) Karyokinesis (c) Anaphase (d) Metaphase

Q4 Kinetochore is located on
(a) Primary constriction (b) telomere (c) Chromatid (d) all

Q5 Spindle Fibre is made up
(a) Protein (b) lipid (c) Nucleic Acid (d) all

Q6 Chromosome loose identity in
(a) Anaphase (b) telophase (c) Metaphase (d) Prophase

Q7 Chromosome condensation Start in
(a) Prophase (b) Metaphase (c) Telophase (d) Anaphase

Q8 Chromosome number get Double in ____ phase of (Caryokinesis)
(a) Prophase (b) Metaphase (c) Anaphase (d) telophase

Q9 Nuclear membrane Disappear in
(a) Prophase (b) Metaphase (c) telophase (d) Anaphase

Q10 Chromosome move Away From spindle Equator
(a) Prophase (b) Metaphase (c) telophase (d) Anaphase

DOPA-01

Q1 DNA Replication start in (Yeast) — Ex

(a) S-phase (b) G_1-phase (c) G_2 phase (d) M-phase

Q2 occur in (Cytoplasm) in S-phase

(a) Centriole double (c) DNA Double (c) nucleolus visible (d) none

Q3 Cell is Enter into Quisant phase means

(a) not Divide (b) Metabolically (Very) Active (c) no Enzyme Activity (d) all

(less)

Q4 Amount of DNA is constant in

(a) G_1 (b) G_2 (c) M (d) S

a ⇐ b

Q5 Amount of DNA in haploid cell in G_1

(a) C (b) 2C (c) 4C (d) 3C

2C 2C

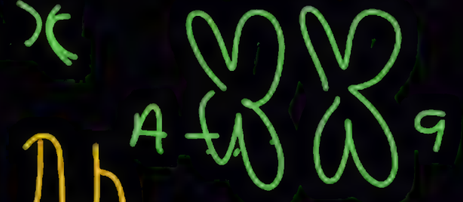
Q6 Amount of DNA in Diploid cell in G_2

(a) 2c (b) 4c (c) 3c (d) 4c

3 — chromosome = chr

Q7 Number of chromatid in cell (2n=16) in G_1 phase

(a) 16 (b) 8 (c) 32 (d) 48



Q8 Number of chromatid in cell (2n=18) in G_2 phase

(a) 36 (b) 18 (c) 9 (d) all

Q9 Which Have same genes

(a) 3rd & 4th chromosome (b) two chromosome of Homologous pair (c) Sister Chromatid (d) all

Q10 Sister chromatids are Double to number of centromere in

(a) G_1 (b) S (c) G_2 (d) none

(a) only S-I correct (b) Both S-I & S-II Correct (c) S-II correct (d) Both wrong

Q11 S-II DNA Replication occur in S-phase in E.coli ✗
S-I DNA Replication occur in G_2-phase in Yeast ✗ ? d

Q12 S-I Amount of DNA not change in M-phase ✗ (d)
S-II Chromosome number get change in G_2 phase ✗

Q13 S-I haploid cell Amount of DNA 2C in G_2 phase ✓ (b)
S-II Diploid cell Amount of DNA 4C in G_2 phase ✓

Q14 S-I Number of Chromosome is 1/4 to the number of cell in G_2 in Gametes
S-II Number of chromosome is 1/2 to the number of cell in G_2 in Egg

40 → 10 (in game)

Ans S-I G_0 phase not show proliferation ✓ (c)
S-II Cell not come back from G_1 to G_0 Even if Require ✗.

(a)

MANTHAN NEET 2025

SANKALP NEET VEDANTU

Cell cycle and cell division

lecture - 4

Botany

TARUN SIR

Topics

Basics of cell cycle

Mitosis

Meiosis

Questions

number of Question = 4-5

level → Easy to medium

Today's Goal

Mitosis – Significance

Meiosis

cell theory

Revision of Mitosis

Prophase

→ Chromatin condense ✓

→ Chromosome appear ✓ – two sister Chromatid

→ Centrosome move to opposite pole

→ Spindle Fibre appear

– ER, Golgi, nucleolus – Disappear ✓

Nuclear membrane – start to break

Metaphase

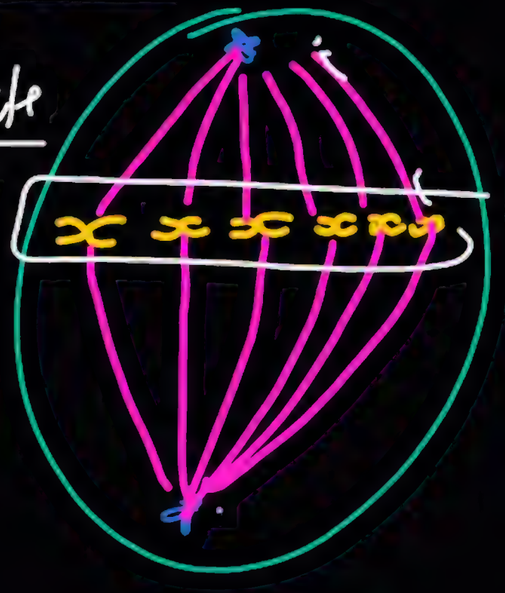
– nuclear membrane Disappear ✓ Disintegrate

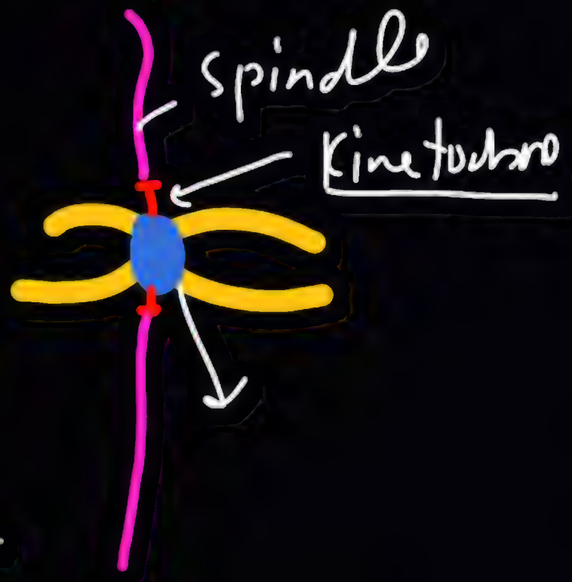
– Chromosome in cytoplasm ✓

– Most condensed – Chromosome ✓

– Kinetochore appear – spindle Attach

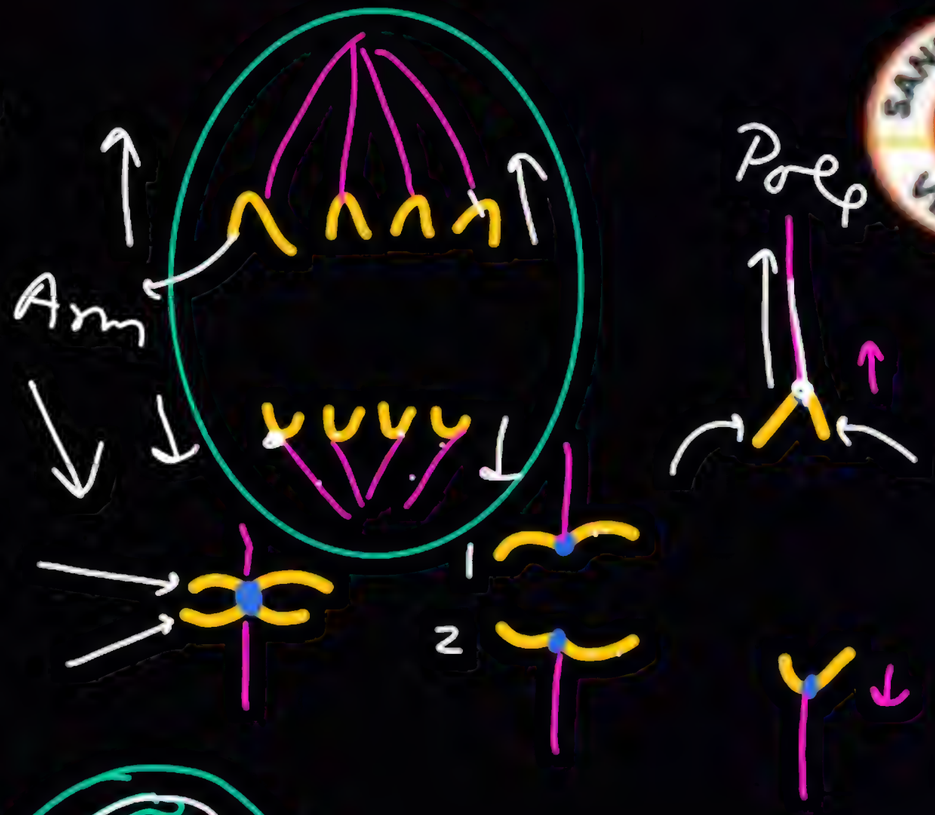
– Chromosome come at Metaphasic plate ✓





Anaphase

→ Sister chromatid split Simultaneously ✓
→ Now – Daughter chromosome
→ Move to opposite pole
→ Centromere – Directed to pole ✓
Arms trailing Behind



Telophase – Chromosomal Material loose Identity

→ Chromatin Appear
→ Nuclear Membrane, ER, golgi
nucleolus Reappear

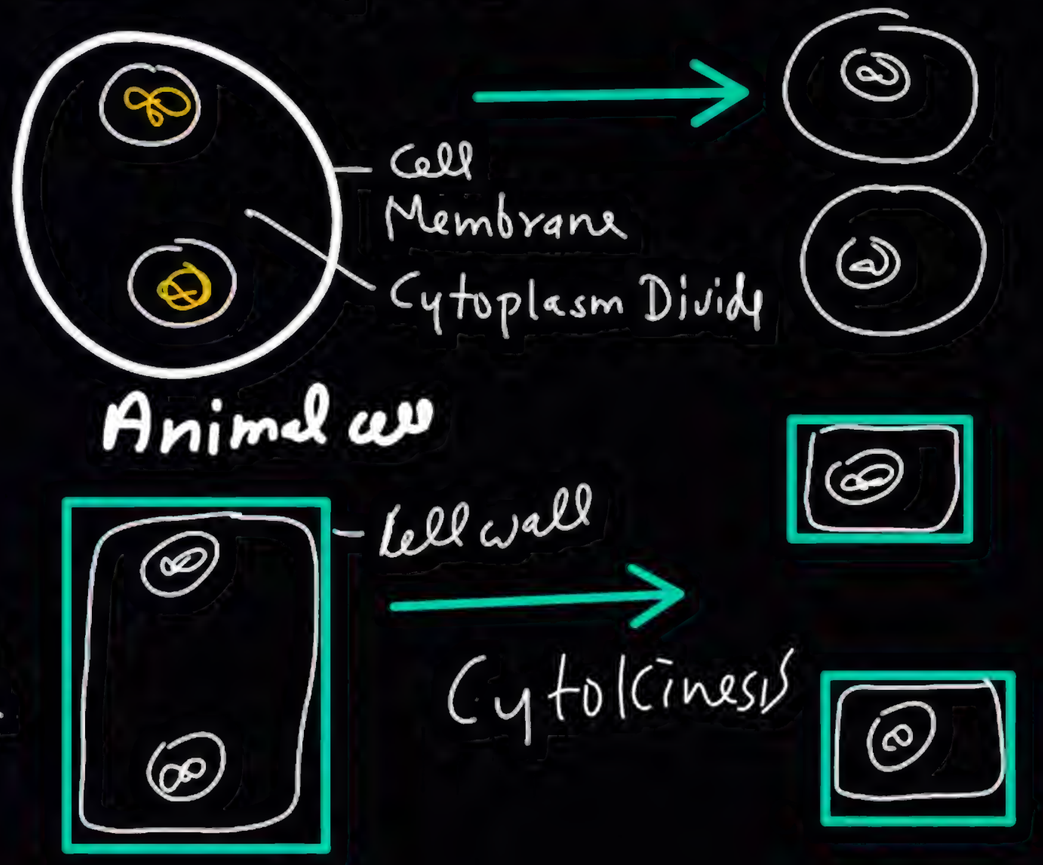
10.2.4 Telophase

At the beginning of the final stage of karyokinesis i.e., telophase, the chromosomes that have reached their respective poles decondense and lose their individuality. The individual chromosomes can no longer be seen and each set of chromatin material tends to collect at each of the two poles (Figure 10.2 d). This is the stage which shows the following key events:

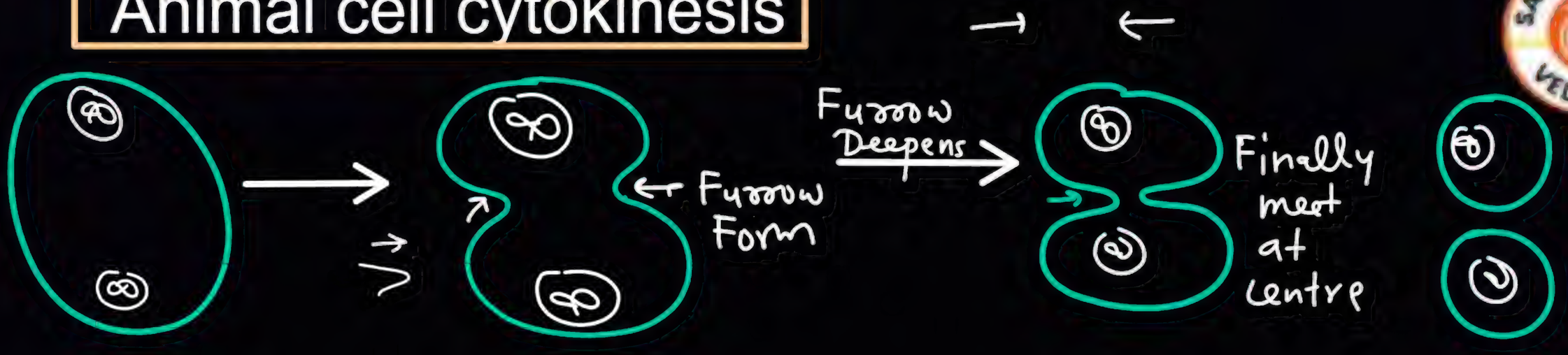
- Chromosomes cluster at opposite spindle poles and their identity is lost as discrete elements.
- Nuclear envelope develops around the chromosome clusters at each pole forming two daughter nuclei.
- Nucleolus, golgi complex and ER reform.

Cytokinesis

- Cell Division is completed when after nuclear Division (Karyokinesis) Cytokinesis (Cytoplasm Division occur)



Animal cell cytokinesis



- Since, Animal cell → Flexible cell Membrane, Furrow develops & meet at centre (Cleavage Method / Centripetal cytokinesis)

division gets completed (Figure 10.2 e). In an animal cell, this is achieved by the appearance of a furrow in the plasma membrane. The furrow gradually deepens and ultimately joins in the centre dividing the cell cytoplasm into two. Plant

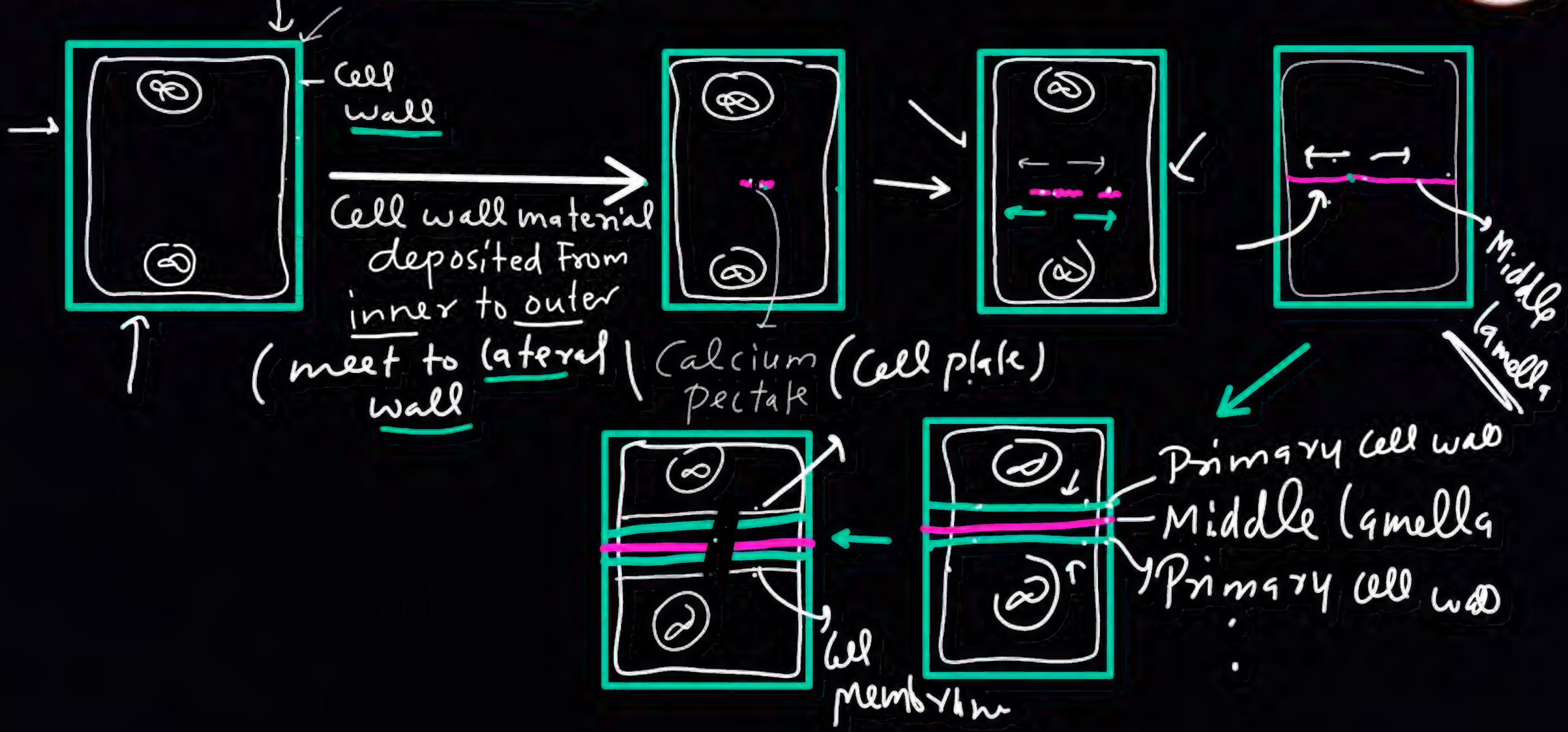
adjacent cells. At the time of cytoplasmic division, organelles like mitochondria and plastids get distributed between the two daughter cells. In some organisms karyokinesis is not followed by cytokinesis as a result of which multinucleate condition arises leading to the formation of syncytium (e.g., liquid endosperm in coconut).

⇒ In some cells → Cytokinesis not occur → Multinucleated (Syncytium)

Ex- Coconut water

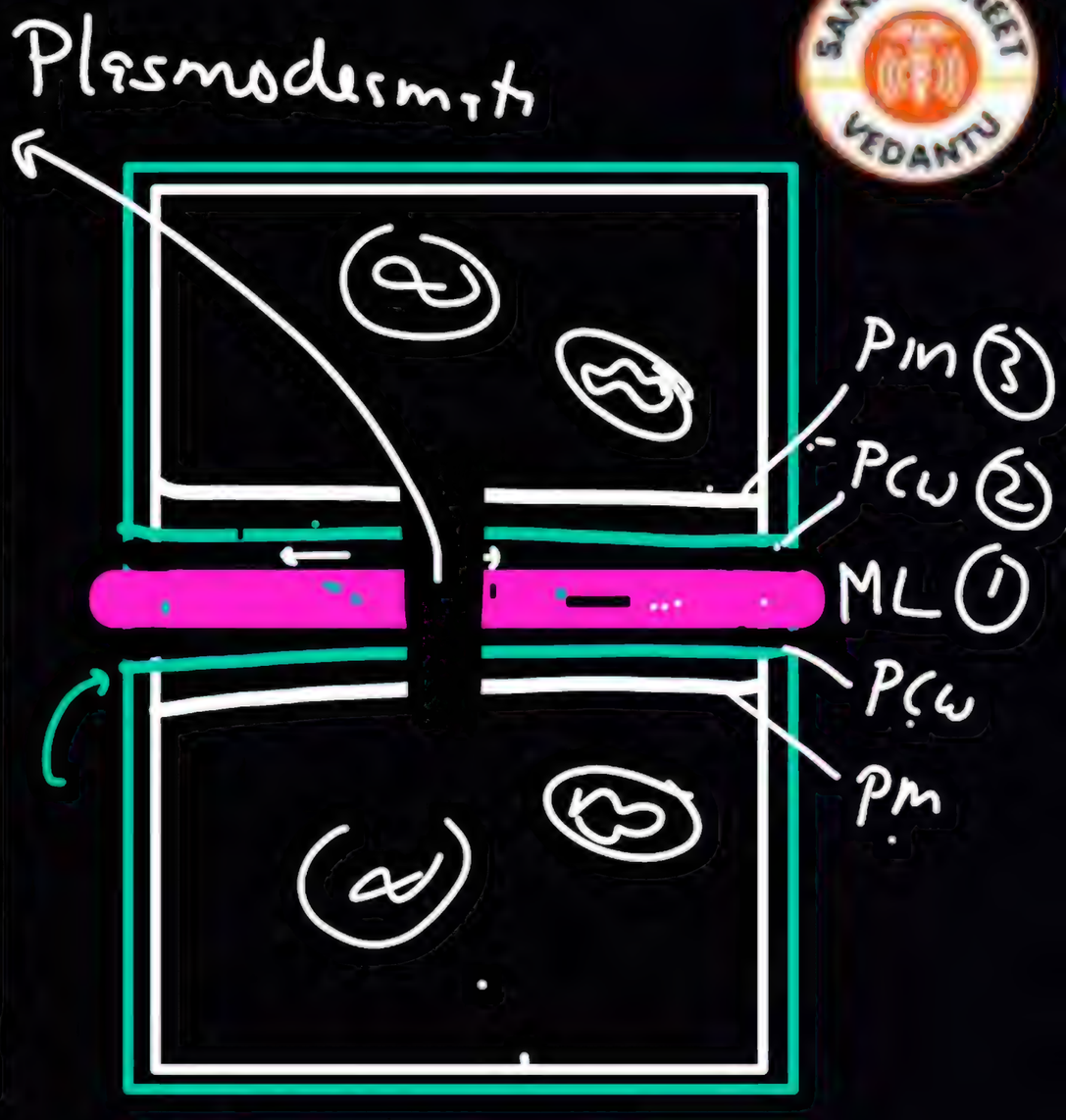
Plant cell cytokinesis (Centrifugal / Cell plate method)

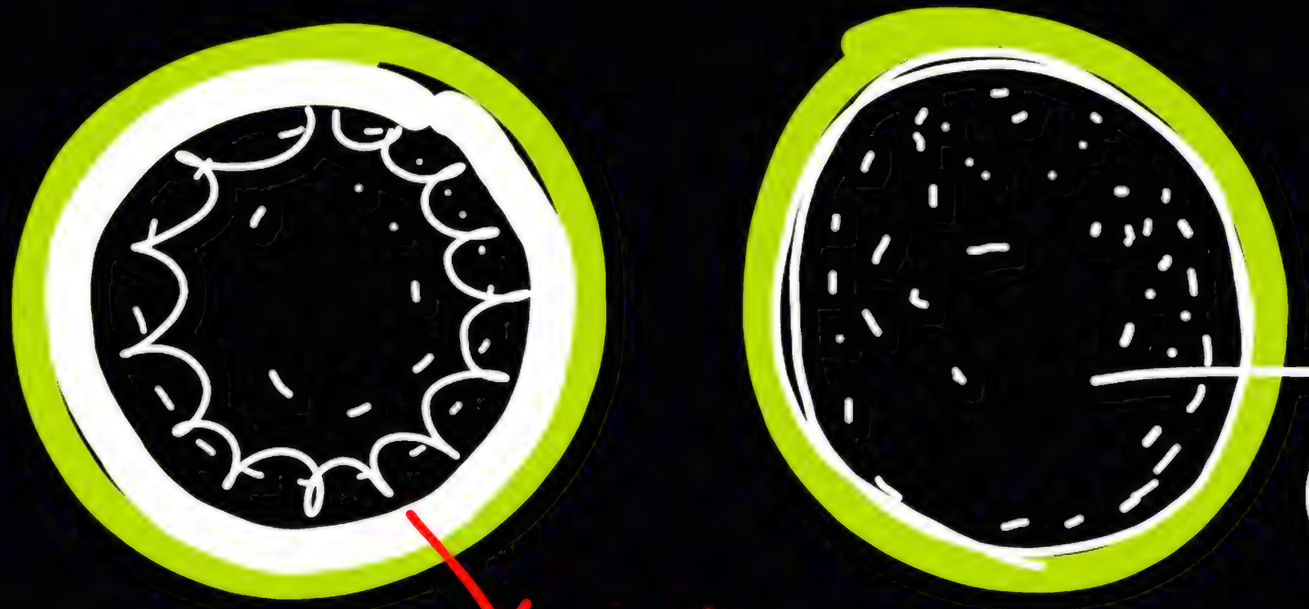
- Plant cell have - Inextensible cell wall | cell wall Rigid → shape not change



Plant cell cytokinesis

joins in the centre dividing the cell cytoplasm into two. Plant cells however, are enclosed by a relatively inextensible cell wall, thererfore they undergo cytokinesis by a different mechanism. In plant cells wall formation starts in the centre of the cell and grows outward to meet the existing lateral walls. The formation of the new cell wall begins with the formation of a simple precursor, called the **cell-plate** that represents the middle lamella between the walls of two adjacent cells. At the time of cytoplasmic division, organelles like mitochondria and plastids get distributed between the

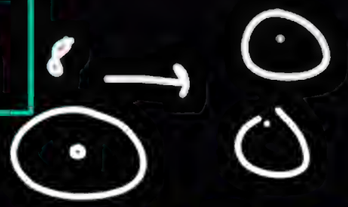




Water
(Free nuclear
Endosperm

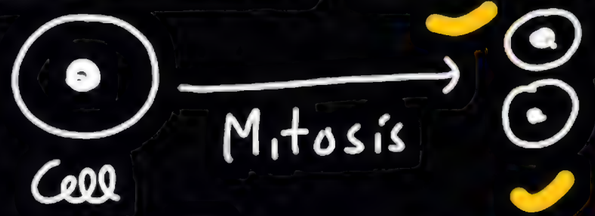
White
Edible part - Cell

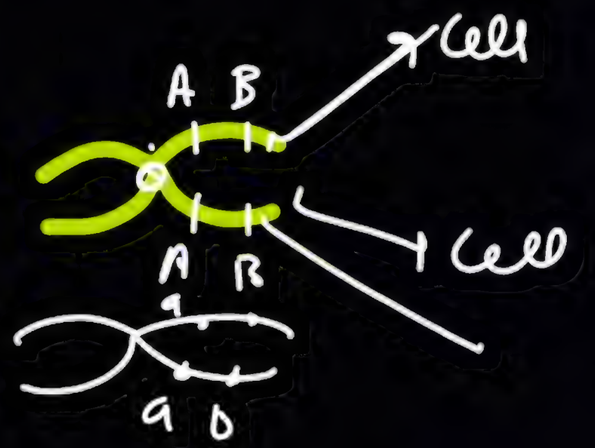
Significance of Mitosis



1. Equational Division – In mitosis, two Daughter cell → Same number of chromosome to parent cell

2. Genetically identical cells –



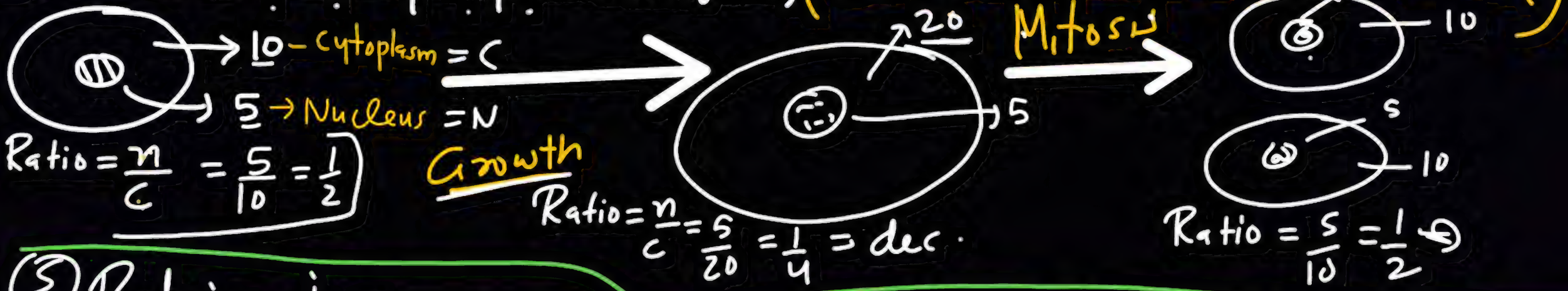


Reason:- Since Sister chromatids, genes same
Each sister chromatid move into two different daughter cell → So cells are Genetically same

3. Growth in multicellular organism → Zygote —Mitosis→ Multicellular organism

(Multicellular organism develop From Single cell → By Mitosis more cells Form → Responsible For Growth

(4) Restore nucleus/cytoplasmic Ratio → (Due to Growth n/c Ratio decrease But due to Mitosis – Ratio 5 → Restore)



(5) Repair – Injury → new cells From By Mitosis – Repair occur

location of Mitosis

- Animals → Epidermis
  - Gut (Alimentary canal)
  - Blood
- Plants
  - Dividing cell name - Meristem
    - Apical Meristem
      - (location - Root tip, Shoot tip)
      - (Apical Meristem)
    - Cambium - Dividing cell
      - Vascular cambium
      - Cork cambium
    - Cambium (Girth Inc.)

→ Since plant Grow throughout Life → Cell Division occur throughout life

Mitosis in haploid and Diploid cell

In animals, mitotic cell division is only seen in the diploid somatic cells. However, there are few exceptions to this where haploid cells divide by mitosis, for example, male honey bees. Against this, the plants can show mitotic divisions in both haploid and diploid cells. From your recollection of examples of alternation of generations in plants (Chapter 3) identify plant species and stages at which mitosis is seen in haploid cells.

Animal → 2n (Diploid) —Mitosis→ Diploid cell

—haploid cell not Form by Mitosis

[In Animal mitosis only occur in Diploid

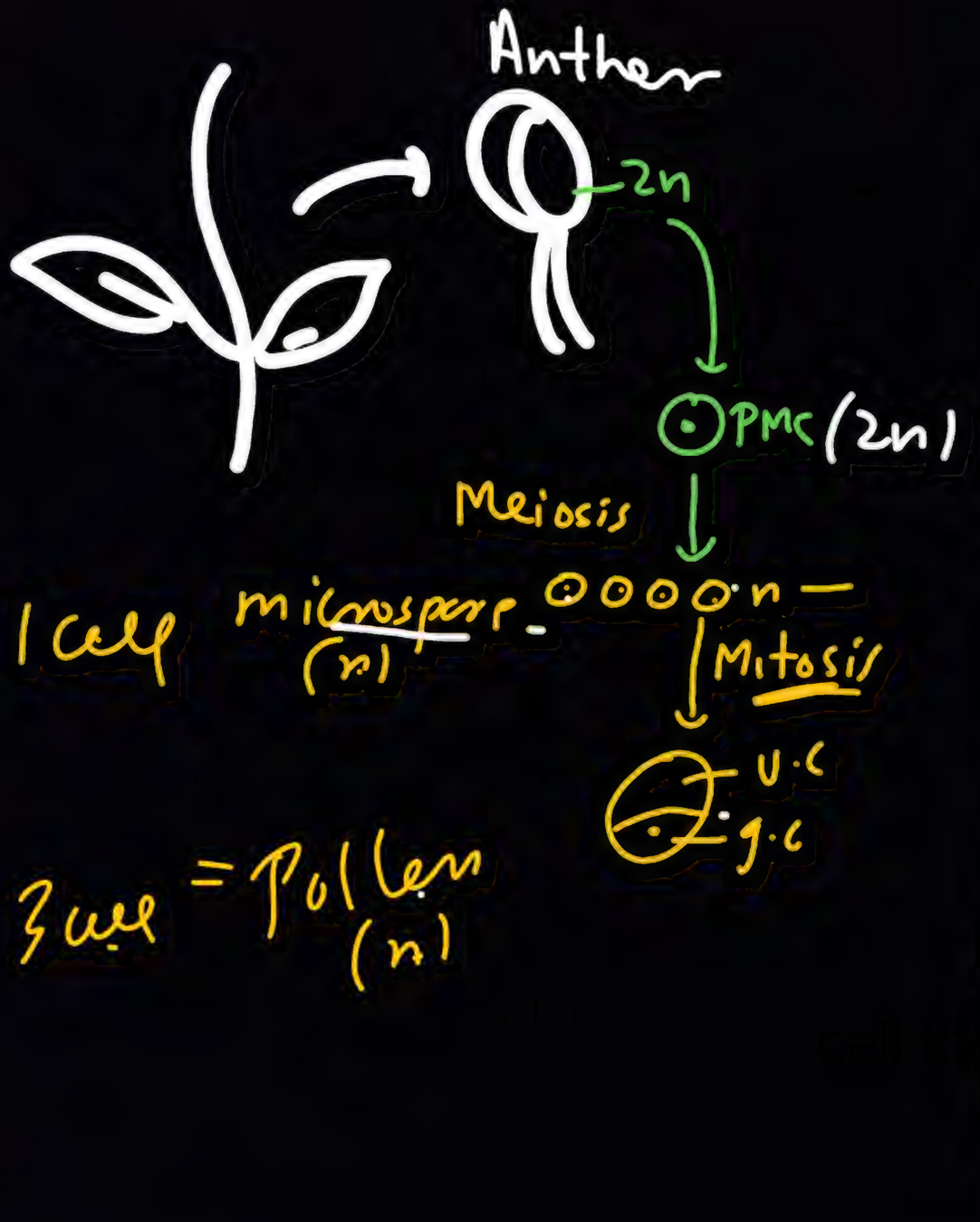
Exception – Social Insect (Honey bee)

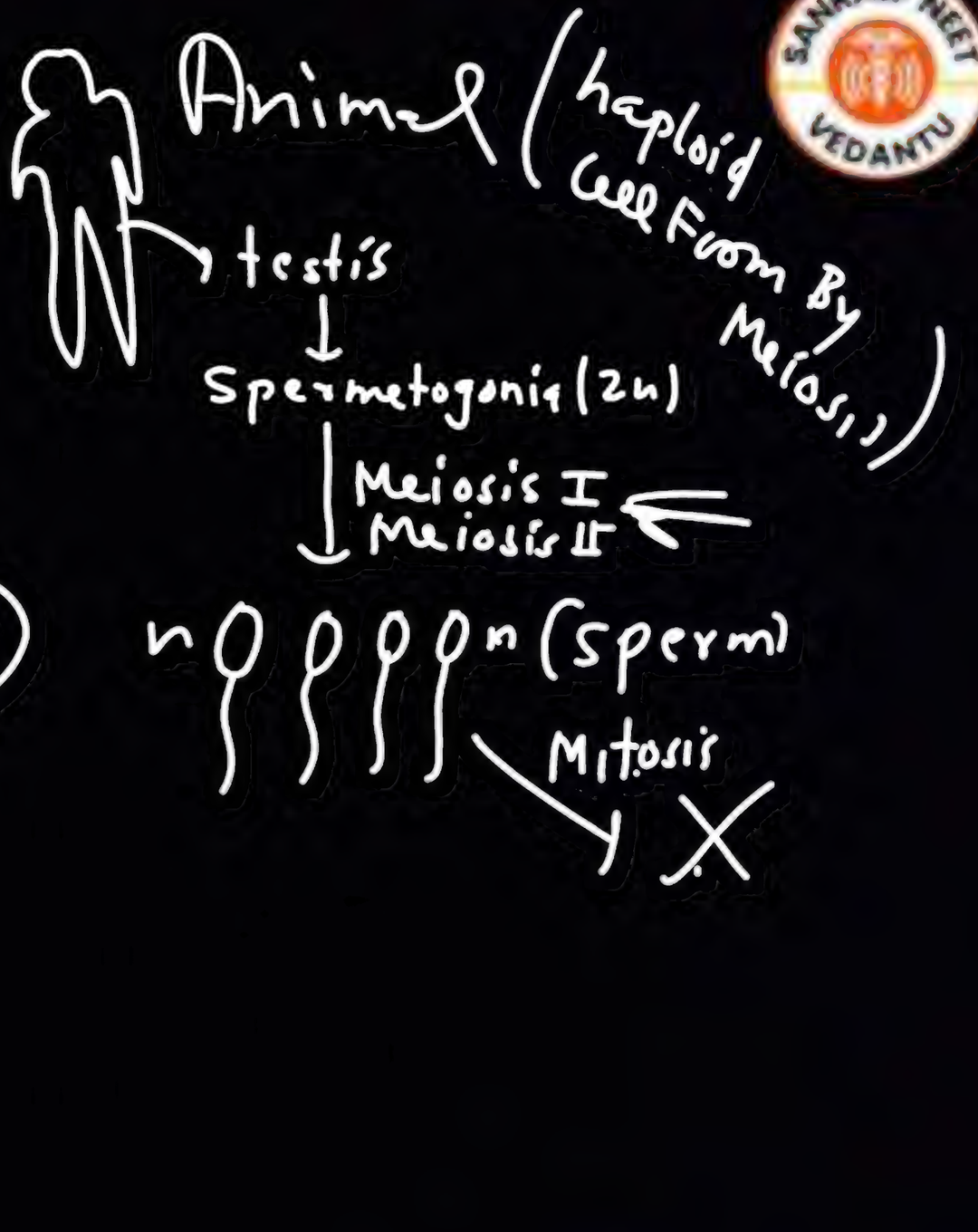
Egg cell (n) —Mitosis→ drone (n) (Male)

Plants → Algae (n) —Mitosis→ n n Haploid

Angiosperm (2n) —Mitosis→ Diploid cell

(In plants mitosis occur in haploid as well as Diploid


Anther
2n
PMC (2n)
Meiosis
microspore (n)
4 cell
Mitosis
V.C
G.C
3 cell = Pollen (n)

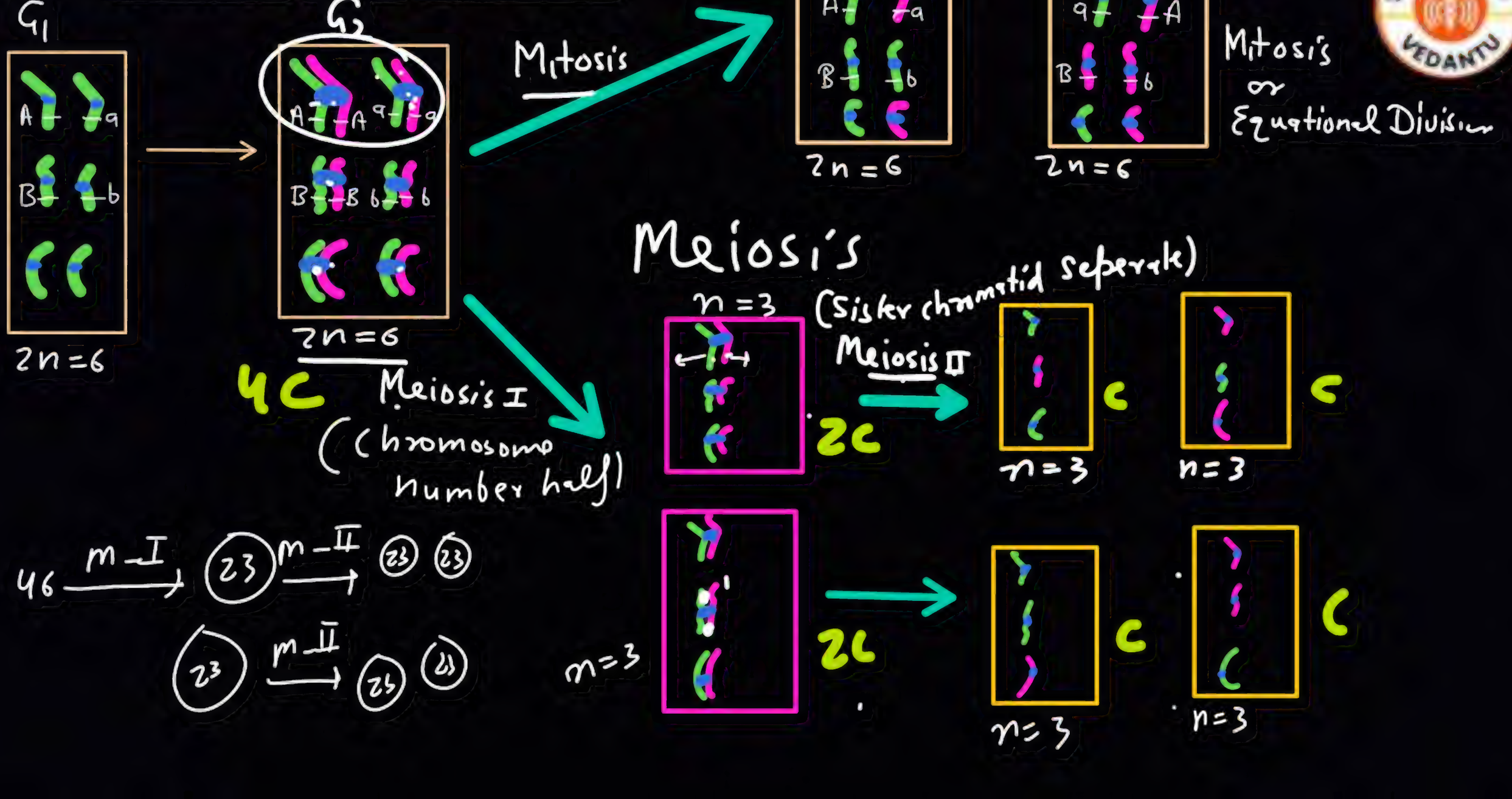

Animal (haploid cell From By Meiosis)
testis
Spermetogonia (2n)
Meiosis I
Meiosis II
n
n (sperm)
Mitosis

10.3 Significance of Mitosis

Mitosis or the equational division is usually restricted to the diploid cells only. However, in some lower plants and in some social insects haploid cells also divide by mitosis. It is very essential to understand the significance of this division in the life of an organism. Are you aware of some examples where you have studied about haploid and diploid insects?

Mitosis usually results in the production of diploid daughter cells with identical genetic complement. The growth of multicellular organisms is due to mitosis. Cell growth results in disturbing the ratio between the nucleus and the cytoplasm. It therefore becomes essential for the cell to divide to restore the nucleo-cytoplasmic ratio. A very significant contribution of mitosis is cell repair. The cells of the upper layer of the epidermis, cells of the lining of the gut, and blood cells are being constantly replaced. Mitotic divisions in the meristematic tissues – the apical and the lateral cambium, result in a continuous growth of plants throughout their life.

Mitosis and Meiosis

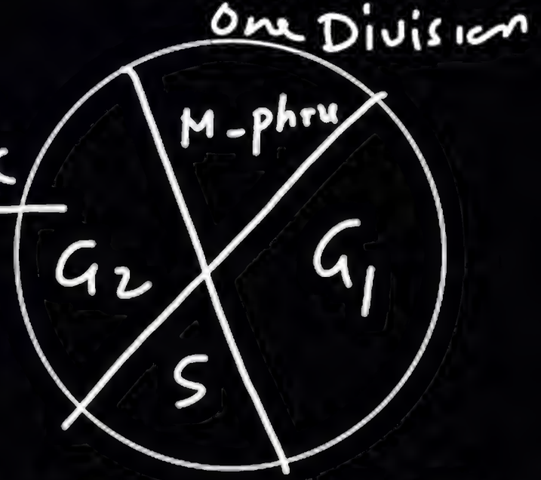


Mitosis

occur in cell → haploid and Diploid

number of Daughter cell → Two daughter cell (Genetically same)

no. of Division — one

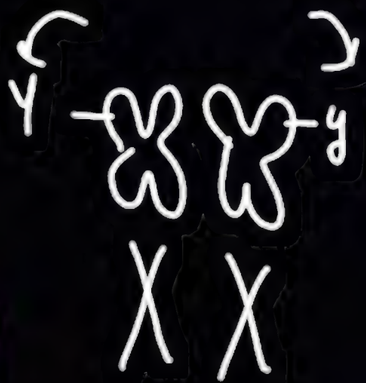


$G_1 \rightarrow S \rightarrow G_2 \rightarrow$ Mitosis

Meiosis

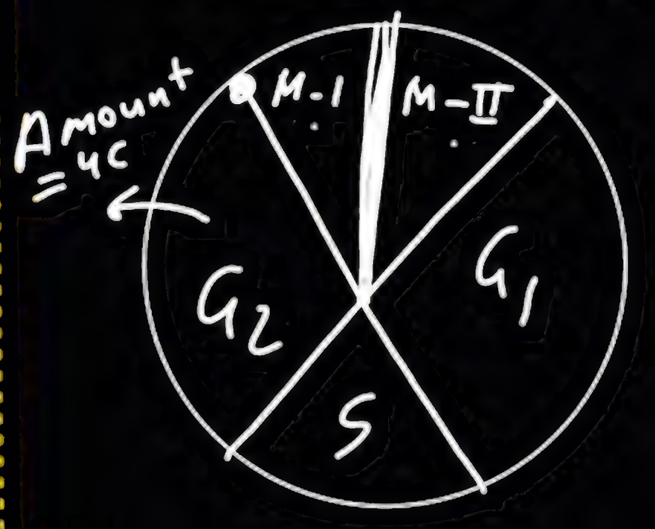
only in Diploid

Four Daughter cell

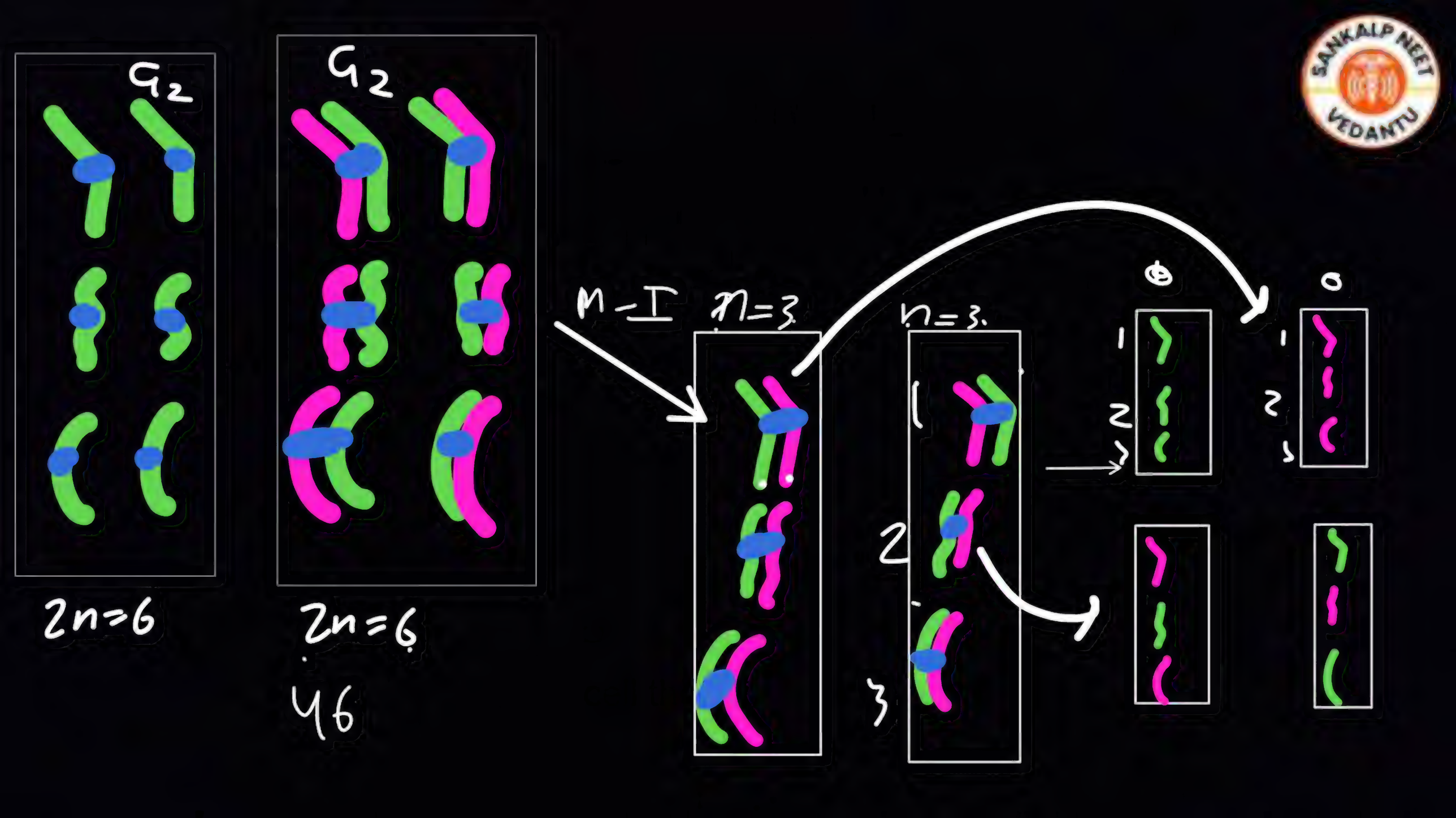


(two division)

no. of Division – Meiosis I & Meiosis II



$G_1 \rightarrow S \rightarrow G_2 \rightarrow$ M-I & M-II


G_2
G_2
2n=6
2n=6
46
M-I
n=3
n=3
2
3
1
2
1
2
1
2
Φ
0

DOPA-03

Q1 Reductional Division is
(a) Mitosis (b) Meiosis (c) Meiosis II (d) all

Q2 Number of chromatid is Equal to no. of centromere in
(a) haploid cell G_2 (b) Diploid cell G_2 (c) Diploid cell G_1 (d) all

Q3 Not Role of Mitosis
(a) Repair (b) Growth in Multicellular organism (c) Restore n/c Ratio (d) dec. N/c Ratio

Q4 Furrow Appear in division of
(a) Mesophyll cell Division (b) Zygote of Human (c) Apical Meristem (d) all

Q5 Coconut water is
(a) Uninucleate Endosperm (b) Multinucleate Endosperm (c) Cotyledon (d) none

Q6 In Mitosis, As compart to G_1 phase of Diploid cell, Amount of DNA in Daughter cell

(a) half (b) Double (c) Same (d) none

Q7 After Meiosis I, Chromosome number is ____ in plant ($2n = 48$) chromosome

(a) 24 (b) 48 (c) 92 (d) 22

Q8 In G_2 phase, number of chromosome is ($2n = 14$) then no. of chromosome after Meiosis II is

(a) 10 (b) 7 (c) 14 (d) 28

Q9 Haploid cells produce By all Except

(a) Mitosis in haploid (b) Meiosis I in Diploid cell (c) Mitosis in Diploid (d) all

Q10 Not possible

(a) Meiosis in Diploid cell (b) Meiosis in Animal cell (c) Meiosis in Plant cell (d) Mitosis in Diploid Animal cell

MANTHAN NEET 2025

Cell cycle and cell division

lecture - 5

Botany

TARUN SIR

Topics

Basics of cell cycle

Mitosis

Meiosis

Questions

number of Question = 4-5

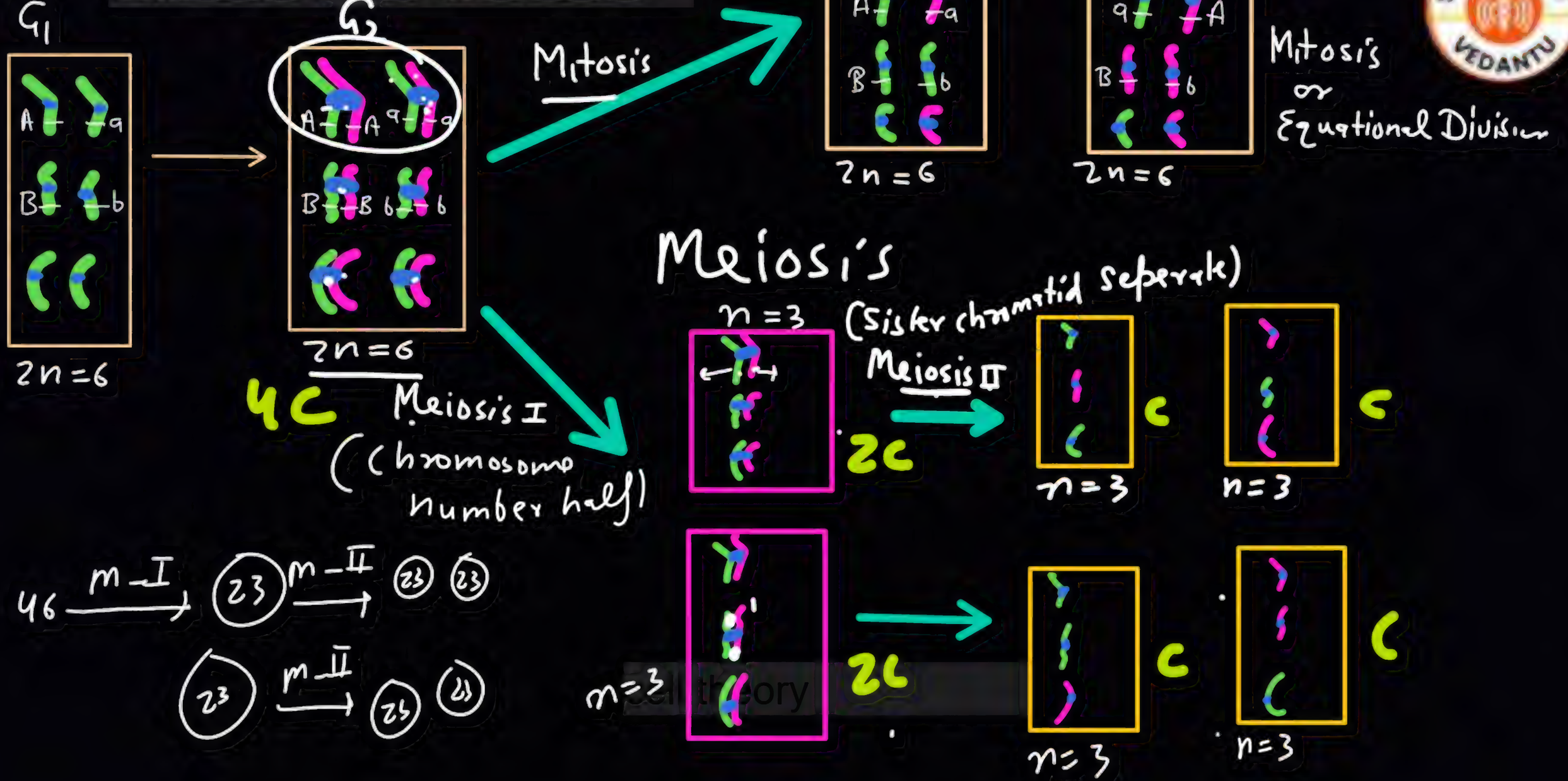
level → Easy to medium

Today's Goal

Meiosis

cell theory

Mitosis and Meiosis

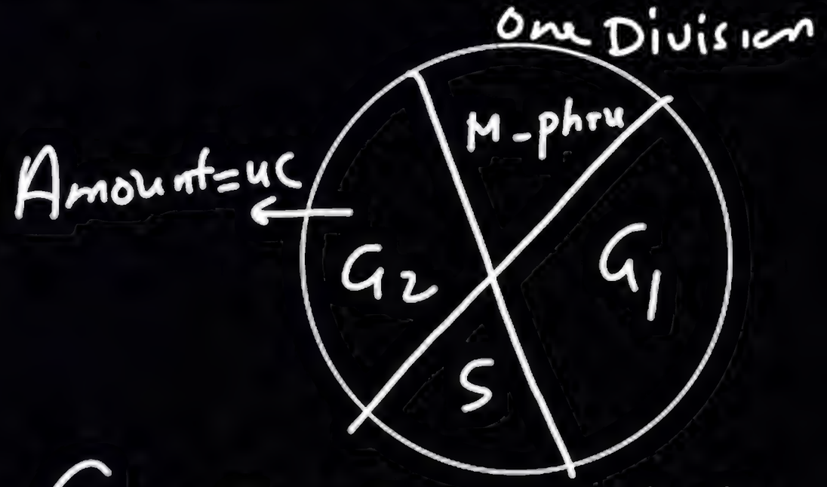


Mitosis

occur in cell → haploid and Diploid

number of Daughter cell → Two daughter cell (Genetically same)

no. of Division — one

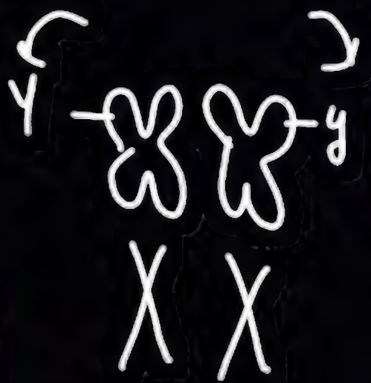


$G_1 \rightarrow S \rightarrow G_2 \rightarrow$ Mitosis

Meiosis

only in Diploid

Four Daughter cell

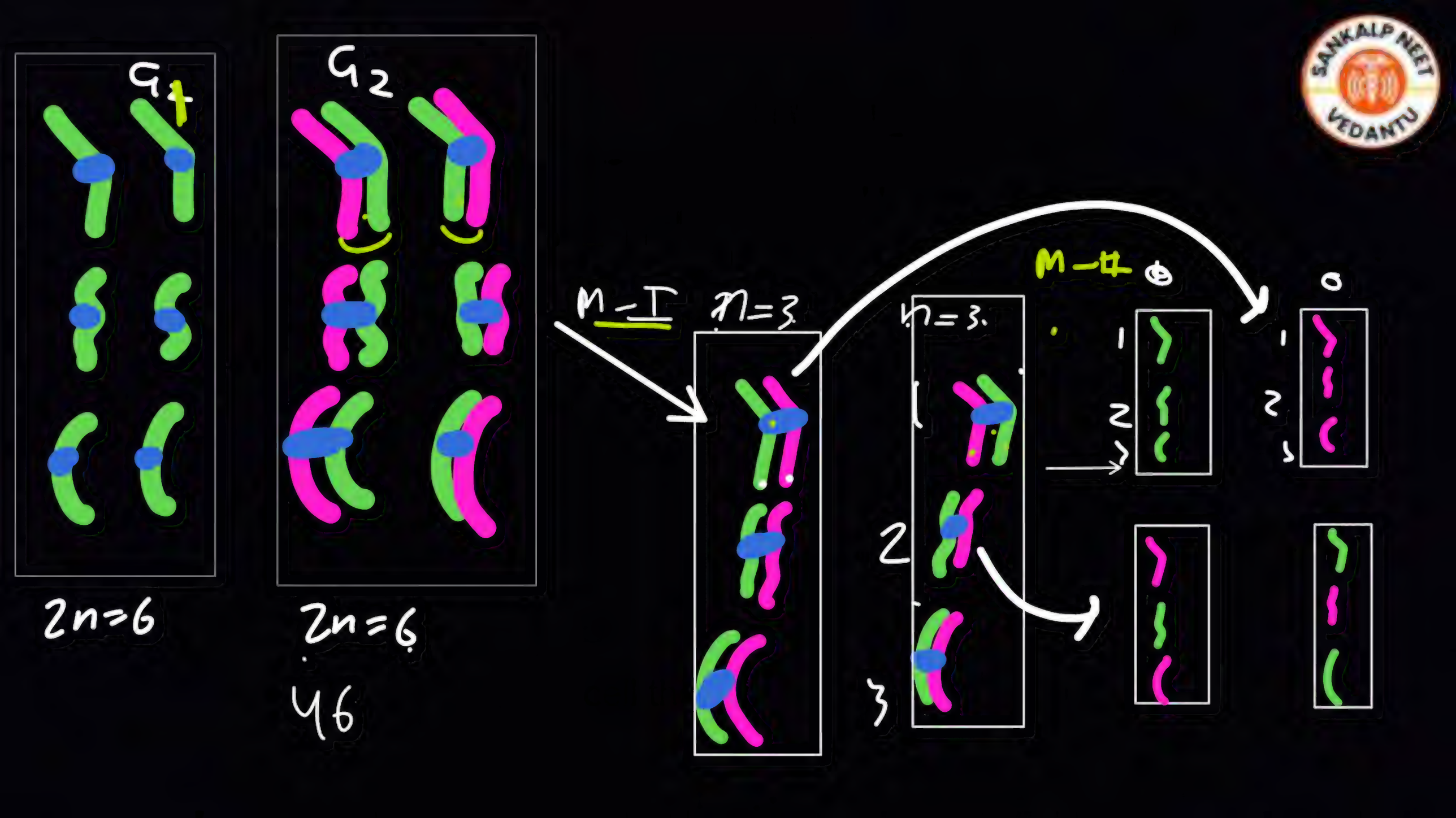


(two division)

no. of Division – Meiosis I & Meiosis II

$G_1 \rightarrow S \rightarrow G_2 \rightarrow$ M-I & M-II

cell theory

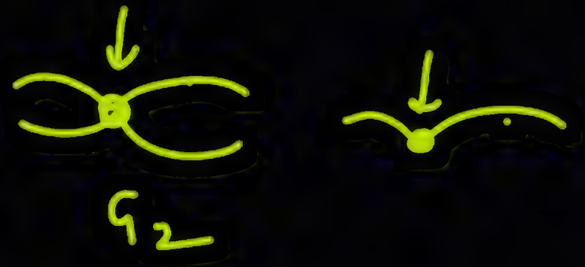

G1
G2
2n=6
2n=6
46
M-I
n=3
n=3.
M-II
0
1
2
1
2
2
3

DOPA-03

→ Chromosome halved

Q1 Reductional Division is
(a) Mitosis (b) Meiosis (c) Meiosis II (d) all

Q2 Number of chromatid is Equal to no. of centromere in
(a) haploid cell G_2 (b) Diploid cell G_2 (c) Diploid cell G_1 (d) all



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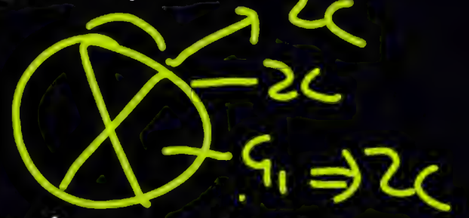
(a) half (b) Double (c) Same (d) none

$G_1 \longrightarrow$



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Q8 In G_2 phase, number of chromosome is ($2n = 14$) then no. of chromosome after Meiosis II is

(a) 10 (b) 7 (c) 14 (d) 28

$2n \xrightarrow{M-I} 7 \quad 7 \xrightarrow{M-II} 7 \quad 7$

$\Rightarrow 14$

Q9 (Haploid cells ave produce By all Except method Except

(a) Mitosis in haploid (b) Meiosis I in Diploid cell (c) Mitosis in Diploid ($2n$) (d) all

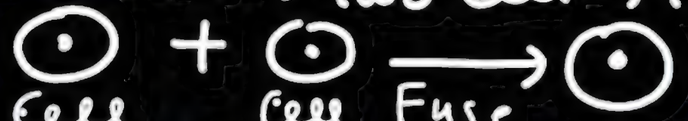
Q10 Not possible

(a) Meiosis in Diploid cell (b) Meiosis in Animal cell (c) Meiosis in Plant cell (d) Mitosis in Haploid Animal cell

What is Requirement of Meiosis

① Source of variation → During S-Phase → DNA Replication → DNA non identical → two daughter cell – not same
Some time problem
(this variation is very less)

② Another source → Two cell → Fuse & combine to form Single cell



(Sexual Reproduction) – more variation (Variation of two cell combine)

Problem → Chromosome Number get Double

Solution → Some type of Division – Chromosome number half ✓
(Meiosis)

- Sexual Reproduction – Require Fusion of two cell ✓
- Fusion of two cell – increase chromosome number ✓
- We need on Division where Chromosome number can be decrease ✓
- This keep chromosome number constant – For species
- So, For variation we need Fusion of cell
  this means Meiosis Related to Sexual Reproduction and Cause Variation ✓

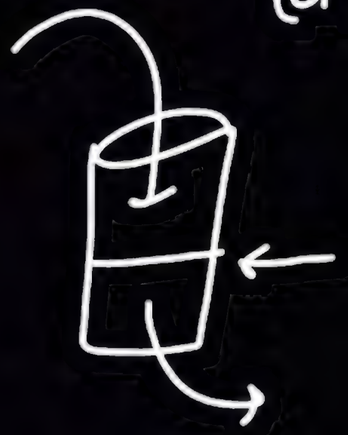
Meiosis

Basics :- (a) occur only in Diploid cell

(b) Meiosis occur to Reduce chromosome number to half
So that Chromosome no. in species Remain constant)

(c) Two time cell Divide, But DNA Replication
Occur once

(d) Meiosis occur only those organism, Sexual Reproduction
(Fusion of Gametes occur)



Meiosis I

Meiosis

Meiosis II

1. Prophase I
2. Metaphase I
3. Anaphase I
4. telophase-I.

Cytokinesis

(No. DNA Replication (B/w M-I & M-II)

Interkinesis

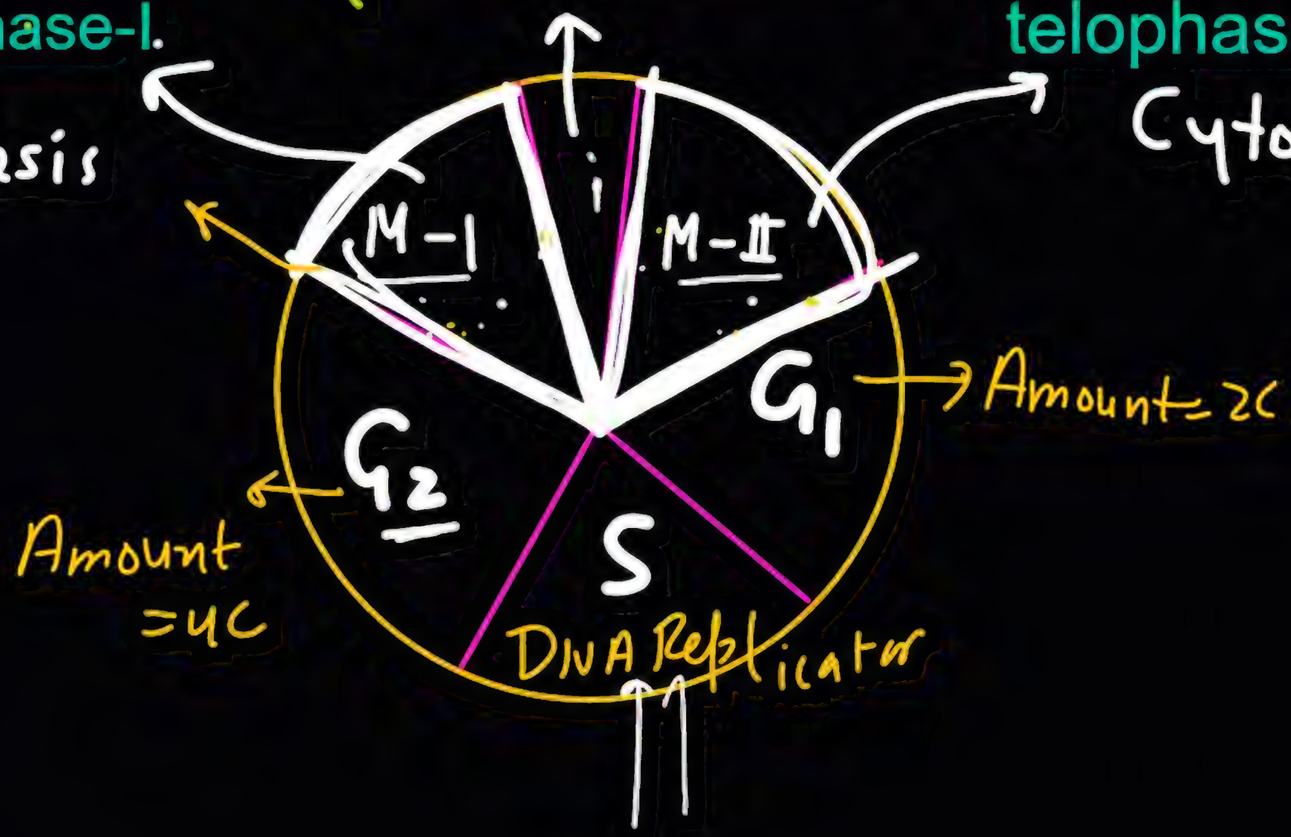
Prophase-II

Metaphase-II

Anaphase-II

telophase-II

Cytokinesis



SANKALP NEET VEDANTU

10.4 Meiosis

The production of offspring by sexual reproduction includes the fusion of two gametes each with a complete haploid set of chromosomes. Gametes are formed from specialised diploid cells. This specialised kind of cell division that reduces the chromosome number by half results in the production of haploid daughter cells. This kind of division is called **meiosis**. Meiosis ensures the production of haploid phase in the life cycle of sexually reproducing organisms whereas fertilisation restores the diploid phase. We come across meiosis during gametogenesis in plants and animals. This leads to the formation of haploid gametes. The key features of meiosis are as follows:

- Meiosis involves two sequential cycles of nuclear and cell division called **meiosis I** and **meiosis II** but only a single cycle of DNA replication.
- Meiosis I is initiated after the parental chromosomes have replicated to produce identical sister chromatids at the S phase.
- Meiosis involves pairing of homologous chromosomes and recombination between non-sister chromatids of homologous chromosomes.
- Four haploid cells are formed at the end of meiosis II.

Meiotic events can be grouped under the following phases:

Meiosis I	Meiosis II
Prophase I	Prophase II
Metaphase I	Metaphase II
Anaphase I	Anaphase II
Telophase I	Telophase II

Cytokinesis.

Meiosis I

Prophase I – Prophase I of meiosis I is more complex and longer to prophase of Mitosis

– It is Subdivided into phase → (On the Basis of Chromosome behaviour)

L (a) leptotene
Z (b) Zygotene
P (c) Pachytene
D (d) Diplotene
D (e) Diakinesis

} Part of prophase I

10.4.1 Meiosis I

Prophase I: Prophase of the first meiotic division is typically longer and more complex when compared to prophase of mitosis. It has been further subdivided into the following five phases based on chromosomal behaviour i.e., Leptotene, Zygotene, Pachytene, Diplotene and Diakinesis.

leptotene — Condensation of Chromatin

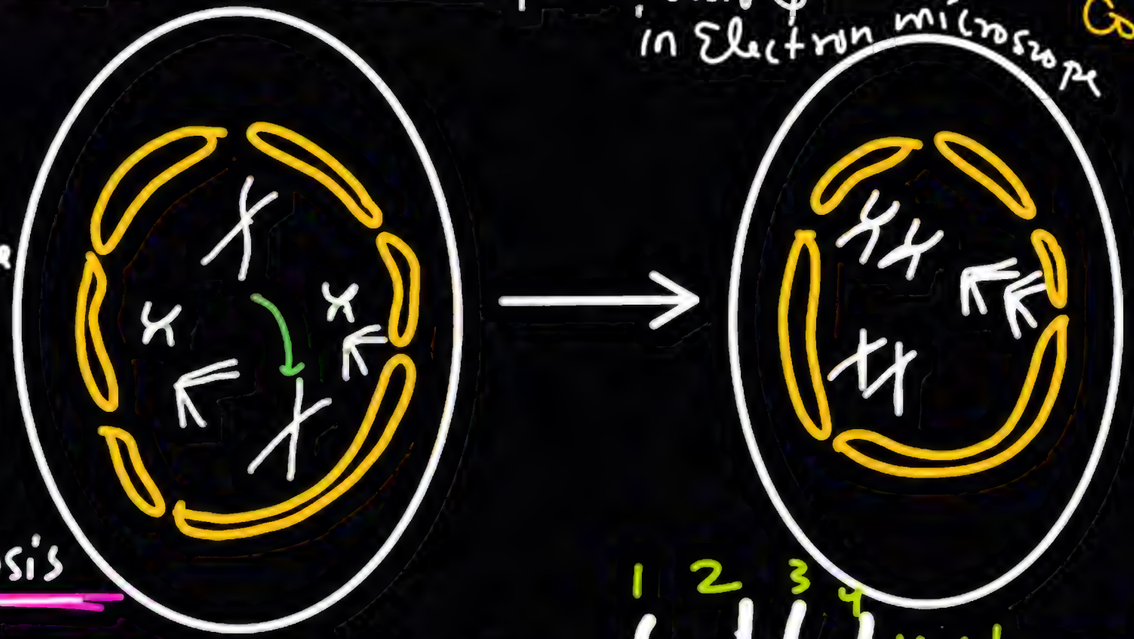
→ Chromatin start to Condense

→ Chromosome start to appear

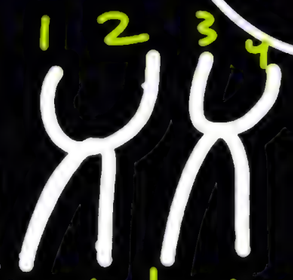
— Condensation/compaction occur throughout this phase

Zygotene

- Leptoten & Zygotene - visible in normal microscope
- Synaptonemal complex - visible in Electron microscope



- Homologus chromosome start to pairing
- Process of Pairing = Synapsis
- Due to pairing - Bivalent or tetrad visible



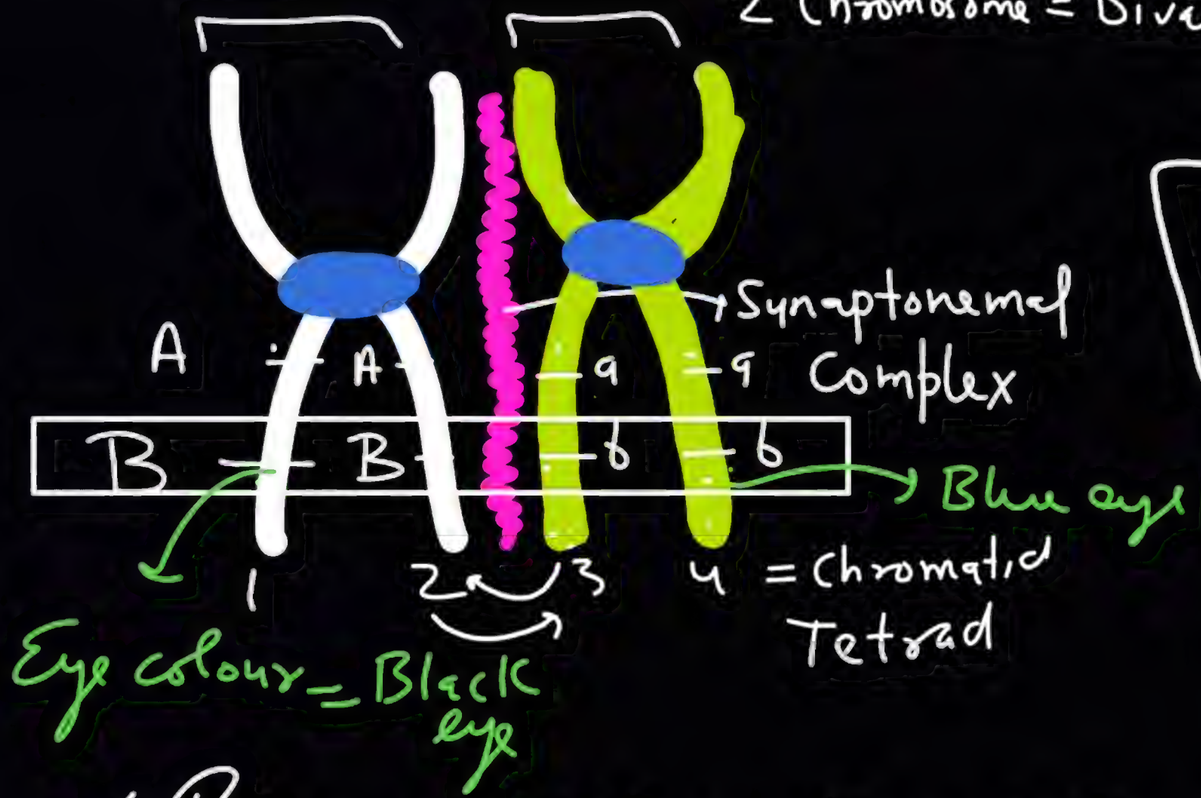
4 chromatid = 1 tetr

1 2 = chromosome

1 Pair =	2 chromosome (Bivalent)	= 4 Chromatid tetrad
Result		

Synaptonemal Complex

Homologus chromosome



Human cell = 2n = 46

23 pair = 23 Bivalent = 23 tetrad

* Reason of pairing → So that Genes Exchange B/w non-sister (Chromatid of Homologus pair)

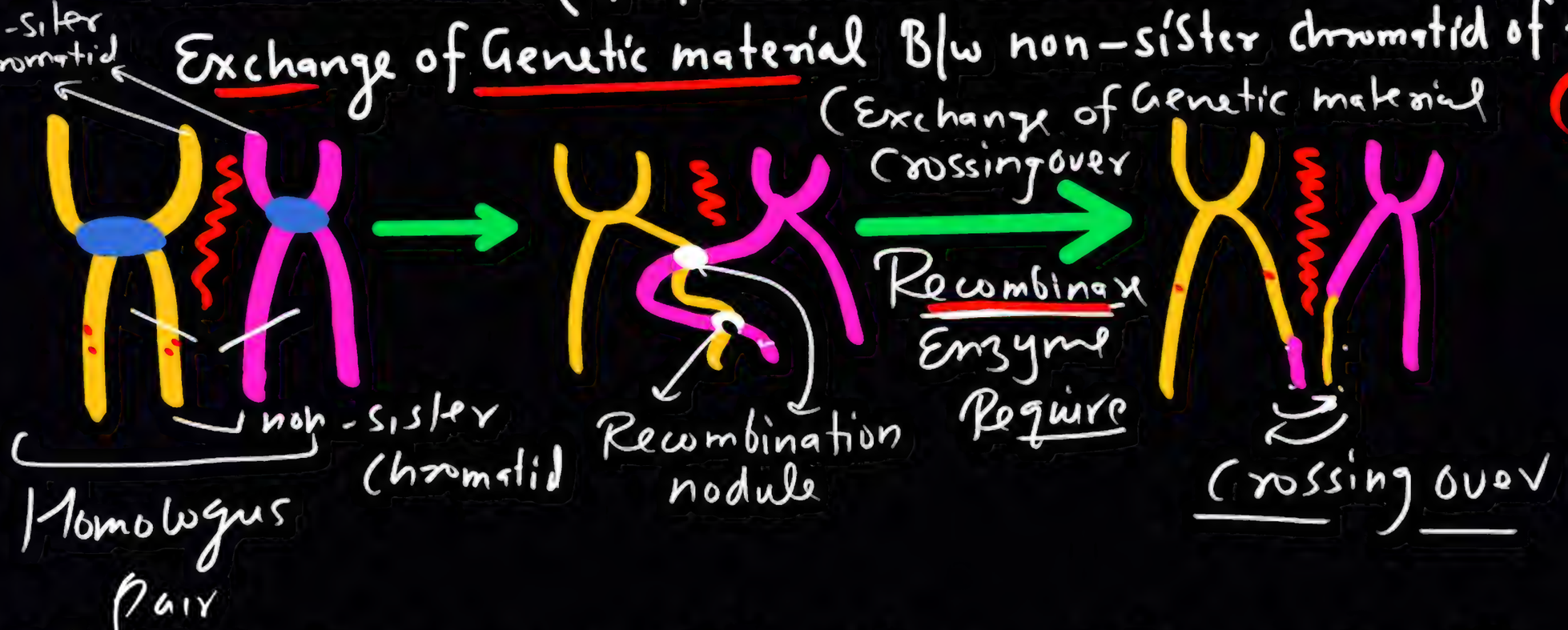
10.4.1 Meiosis I

Prophase I: Prophase of the first meiotic division is typically longer and more complex when compared to prophase of mitosis. It has been further subdivided into the following five phases based on chromosomal behaviour, i.e., Leptotene, Zygotene, Pachytene, Diplotene and Diakinesis.

During **leptotene** stage the chromosomes become gradually visible under the light microscope. The compaction of chromosomes continues throughout leptotene. This is followed by the second stage of prophase I called **zygotene**. During this stage chromosomes start pairing together and this process of association is called synapsis. Such paired chromosomes are called homologous chromosomes. Electron micrographs of this stage indicate that chromosome synapsis is accompanied by the formation of complex structure called **synaptonemal complex.** The complex formed by a pair of synapsed homologous chromosomes is called a **bivalent** or a tetrad. However,

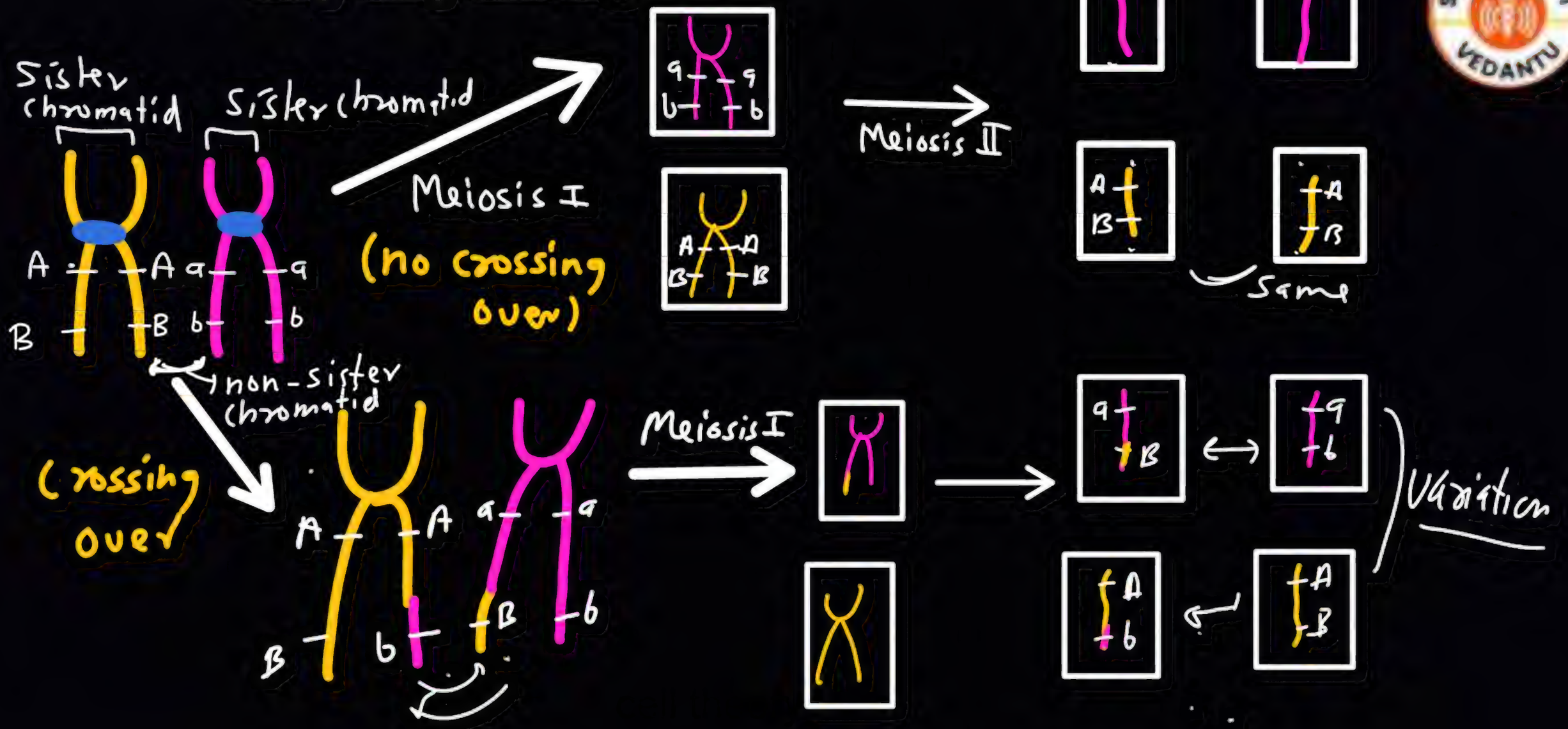
Pachytene

- Bivalent - Form in Zygotene ✓
  Clearly visible in pachytene ✓
- Paired chromosome (Synapsed chromosome or Bivalent or tetrad)
- Exchange of Genetic material B/w non-sister chromatid of Homologus pair (Exchange of Genetic material Crossingover ((Crossing over))



After Crossing over sister chromatids genetically non-identical

Why they are together



these are more clearly visible at the next stage. The first two stages of prophase I are relatively short-lived compared to the next stage that is **pachytene**. During this stage, the four chromatids of each bivalent chromosomes becomes distinct and clearly appears as tetrads. This stage is characterised by the appearance of recombination nodules, the sites at which crossing over occurs between non-sister chromatids of the homologous chromosomes. Crossing over is the exchange of genetic material between two homologous chromosomes. Crossing over is also an enzyme-mediated process and the enzyme involved is called recombinase. Crossing over leads to recombination of genetic material on the two chromosomes. Recombination between homologous chromosomes is completed by the end of pachytene, leaving the chromosomes linked at the sites of crossing over.

The beginning of **diplotene** is recognised by the dissolution of the synaptonemal complex and the tendency of the recombined homologous chromosomes of the bivalents to separate from each other except at the sites of crossovers. These X-shaped structures, are called **chiasmata.** In oocytes of some vertebrates, diplotene can last for months or years.

Diplotene

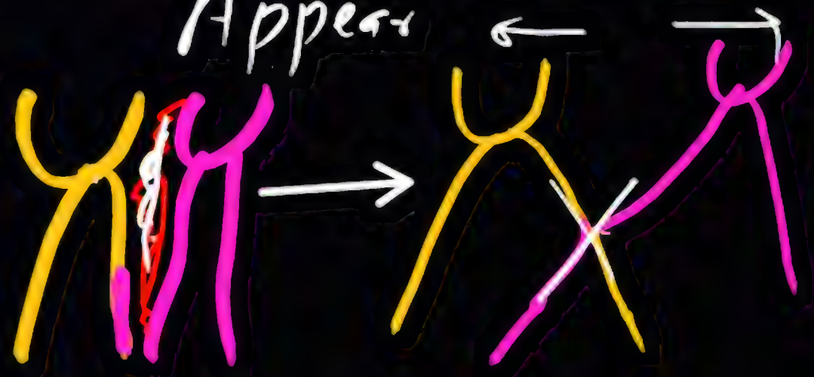
- Synaptonemal Dissolve
- Chromosome start to move Away
- Chiasmata appear

* Synaptonemal complex Start to Dissolve (Dissolution
* Chromosome of Homologus pair Start to move Apart
* Chromosome Found to Attach at location - At location of Cross over

Synaptonemal Complex

Note - In some mammals oocyte Arrest in Diplotene

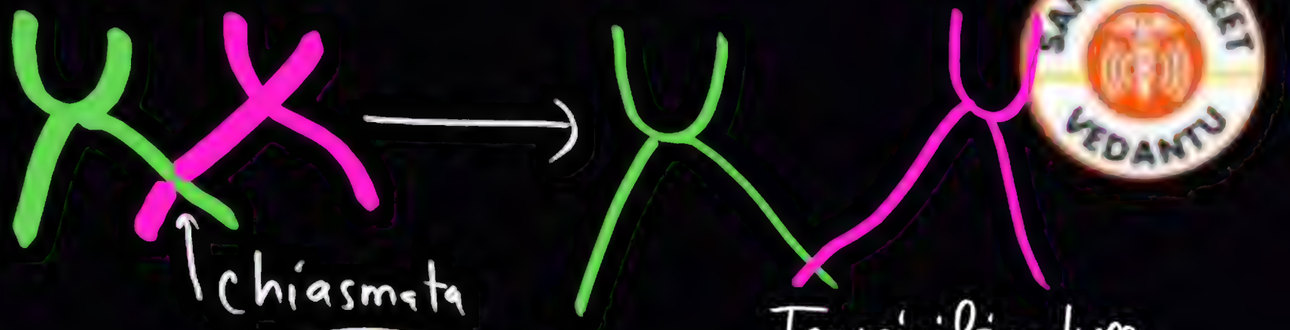
Appear

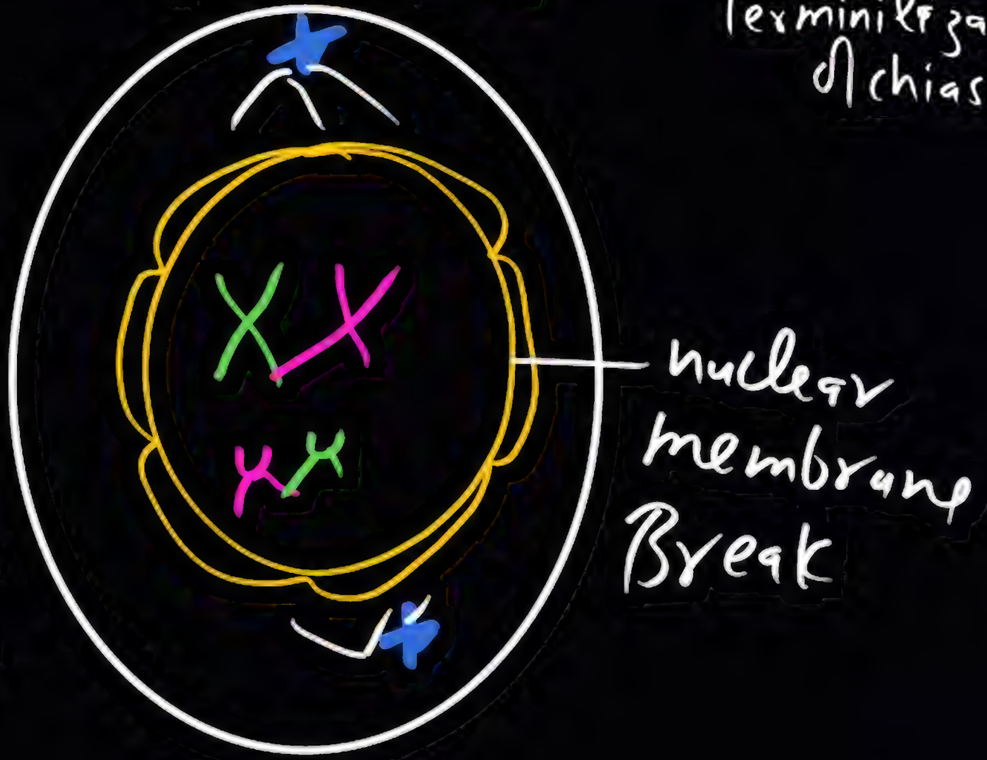


- Cross like structure Appear (Chiasmata)

Diakinesis

- Terminilization of chiasmata
- Rest of change of Prophase occur
  - Centrosome move to opposite pole (Spindle Fibre Arise)
  - ER, Golgi, nucleolus – Disappear
  - nuclear membrane Disintegrate
- ✡ Chromosome fully condense ✓





The final stage of meiotic prophase I is **diakinesis.** This is marked by terminalisation of chiasmata. During this phase the chromosomes are fully condensed and the meiotic spindle is assembled to prepare the homologous chromosomes for separation. By the end of diakinesis, the nucleolus disappears and the nuclear envelope also breaks down. Diakinesis represents transition to metaphase.

Metaphase I: The bivalent chromosomes align on the equatorial plate (Figure 10.3). The microtubules from the opposite poles of the spindle attach to the kinetochore of homologous chromosomes.

MANTHAN NEET 2025

SANKALP NEET VEDANTU

Cell cycle and cell division

lecture – 6

Botany

TARUN SIR

Topics

Basics of cell cycle

Mitosis

Meiosis

Questions

number of Question = 4-5

level → Easy to medium

Today's Goal

Meiosis

cell theory

Meiosis I ← Meiosis → Meiosis II

1. Prophase I
2. Metaphase I
3. Anaphase I
4. telophase-I.

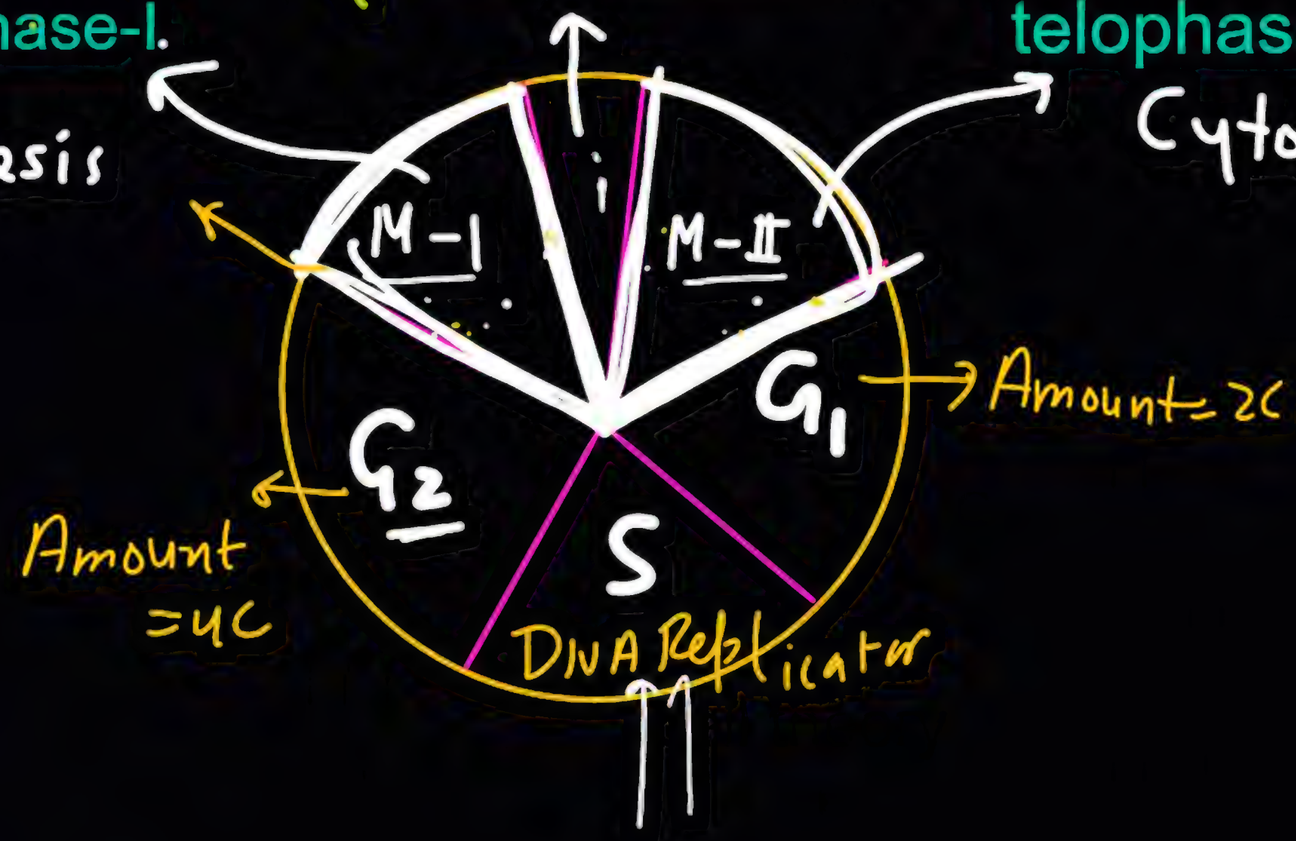
Cytokinesis

(No. DNA Replication (B/w M-I & M-II))

Interkinesis

Prophase-II
Metaphase-II
Anaphase-II
telophase-II

Cytokinesis



SANKALP NEET VEDANTU

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cell theory

- Meiosis involves two sequential cycles of nuclear and cell division called **meiosis I** and **meiosis II** but only a single cycle of DNA replication.
- Meiosis I is initiated after the parental chromosomes have replicated to produce identical sister chromatids at the S phase. G_2-4c
- Meiosis involves pairing of homologous chromosomes and recombination between non-sister chromatids of homologous chromosomes.
- Four haploid cells are formed at the end of meiosis II.

G_2 (4c) M-I → M-II → n n n n

Meiotic events can be grouped under the following phases:

Meiosis I	Meiosis II
Prophase I	Prophase II
Metaphase I	Metaphase II
Anaphase I	Anaphase II
Telophase I	Telophase II

Cytokinesis.

Meiosis I

Prophase I – Prophase I of meiosis I is more complex and longer to prophase of Mitosis

– It is Subdivided into phase → (On the Basis of Chromosome behaviour)

L (a) leptotene
Z (b) Zygotene
P (c) Pachytene
D (d) Diplotene
D (e) Diakinesis

→ Part of prophase I

Meiosis I (Prophase I)

Leptotene — Compaction of chromatin

Zygotene — Pairing → (Process of Pairing – Synapsis)
→ Synaptonemal complex
→ Bivalent = tetrad

Pachytene — Clearly visible ✓
— Recombination/Exchange B/w → Non sister Chromat.
— Recombination nodule → Recombined
— Crossing over

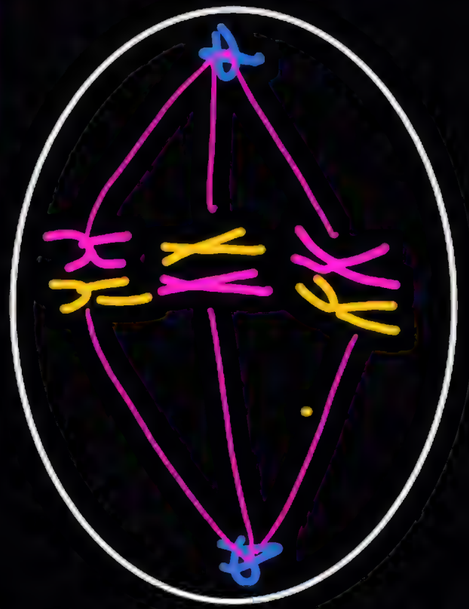
Diplotene → Dissolution of Synaptonemal complex
→ Chromosome tend to move Away
→ Chiamata visible

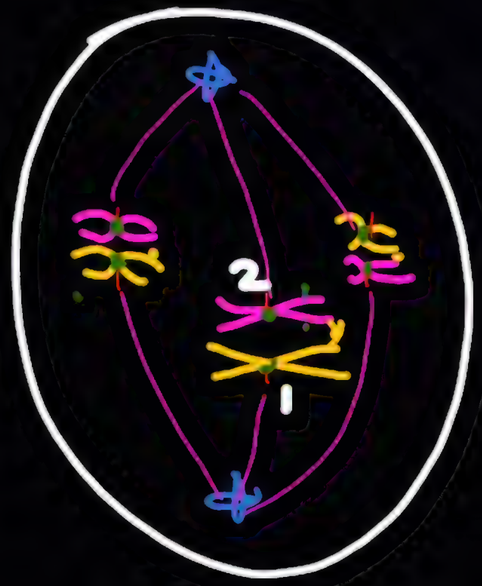
Diakinesis → terminalisation of chiasmata
— ER, Golgi & Nucleolus Disappear → Disappear
Nuclear membrane

metaphase I

- Spindle Fibre attach
- One pair of chromosome attach to both pole

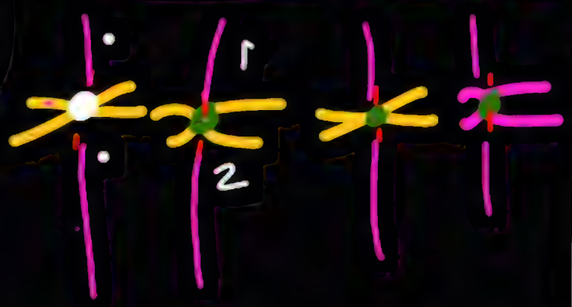
→ Chromosome come at metaphasic plate (Double Metaphasic plate)



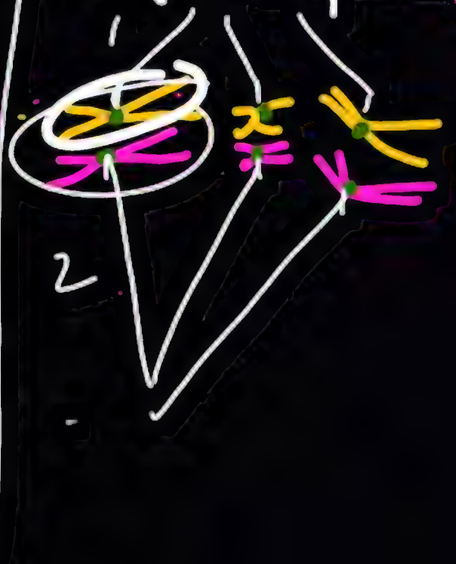


1 pair = 2 Spindle fibre (Both pole)

Mitosis → Metaphase



Meiosis (Metaphase I



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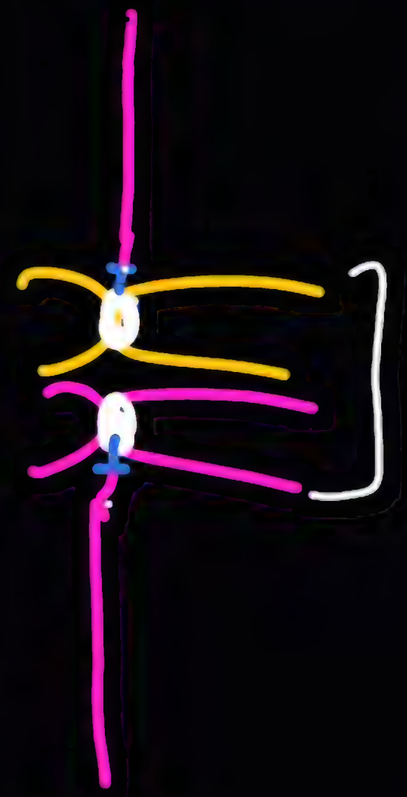
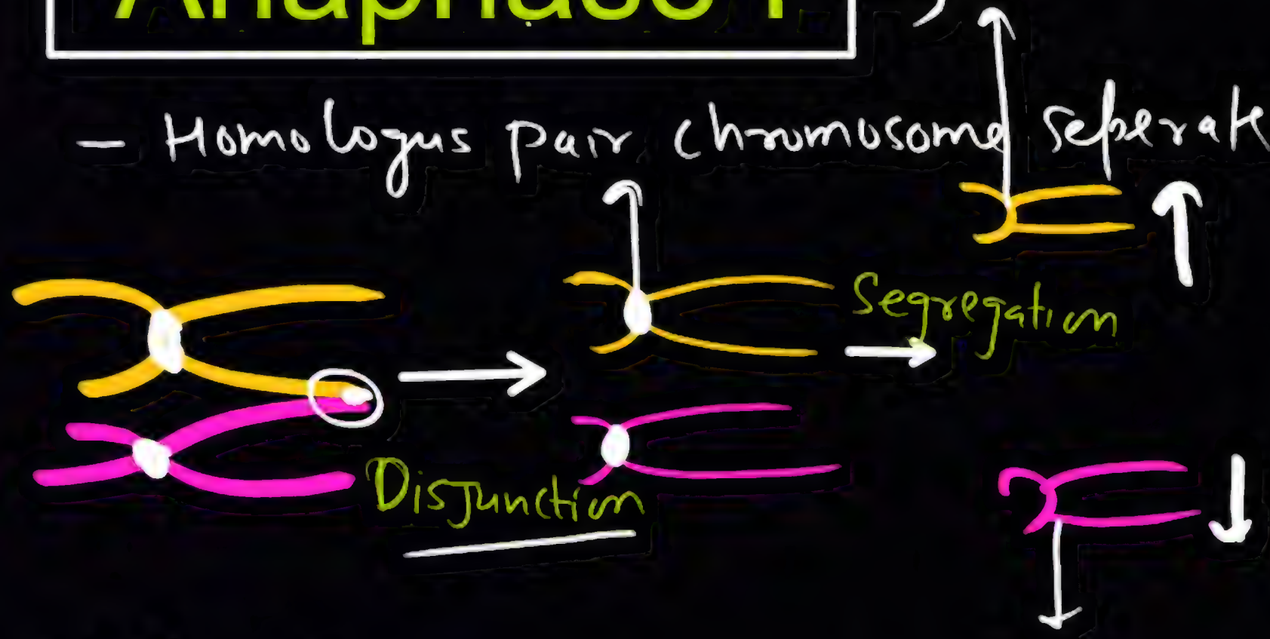
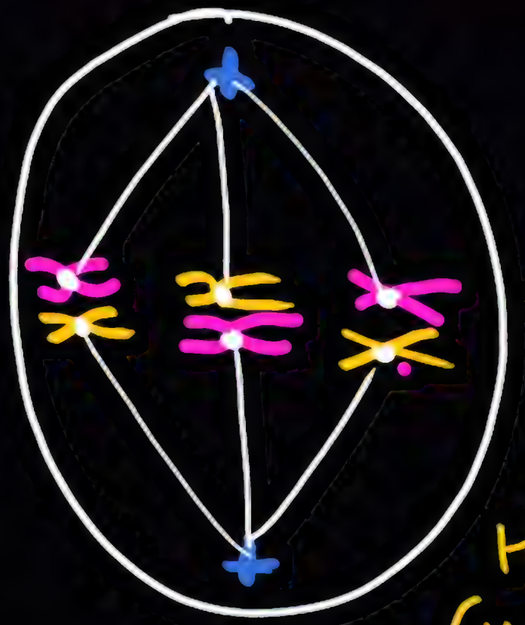
Spindle



Anaphase I

- Homologus pair chromosome seperate



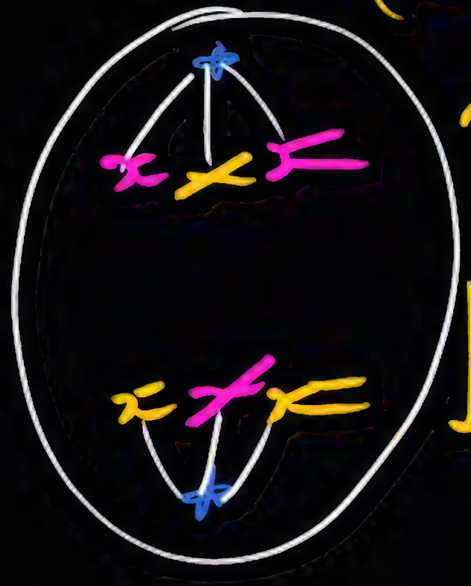


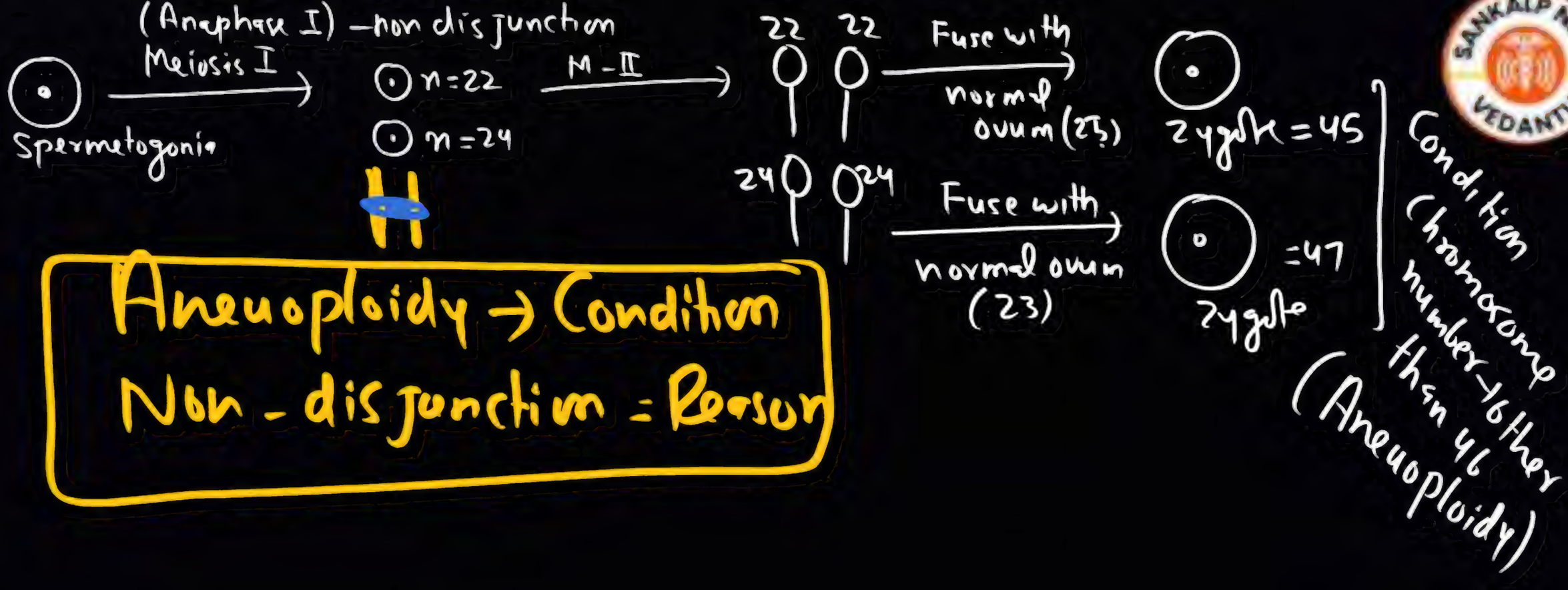
if Human cell (46 → 23↑ 23↓

* If non disjunction occur - Entire pair move Above

→ normal situation (4 Above 4 below)

→ non disjunction → 5 Above 3 below)





Aneuploidy → Condition

Non-disjunction = Reason

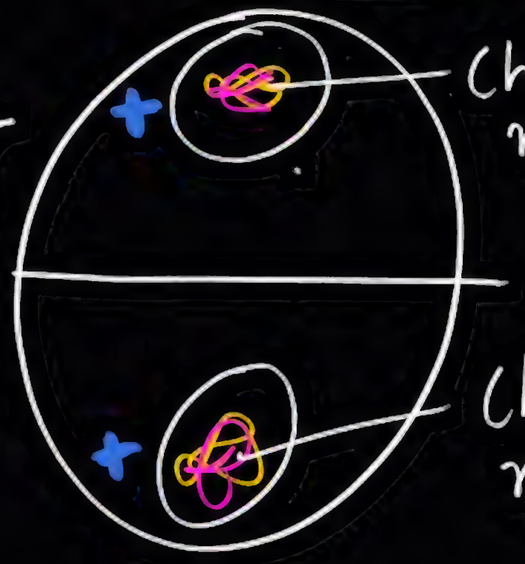
Telophase I

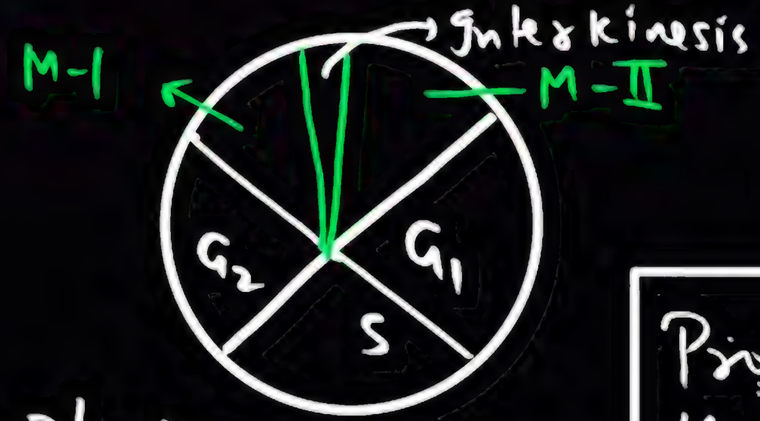
- Chromosome decondense to form chromatin

→ Nuclear membrane, ER, Golgi body Reappear

→ Two haploid <u>nuclei</u> form

Cytokinesis ⟶ Can occur or it can occur after Meiosis II





Meiosis I

Prophase I
Metaphase I
Anaphase I
Telophase I

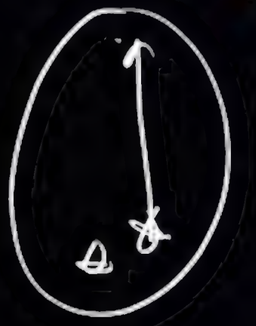
Prophase II
Metaphase II
Anaphase II
telophase II

(Gap B/w M-I & M-II

Interkinesis

→ Short lived

- Chromosome not come in complete Extended Stalk like interphase
- No DNA Replication
- Centriole/Centrosome Double hote ☆]←

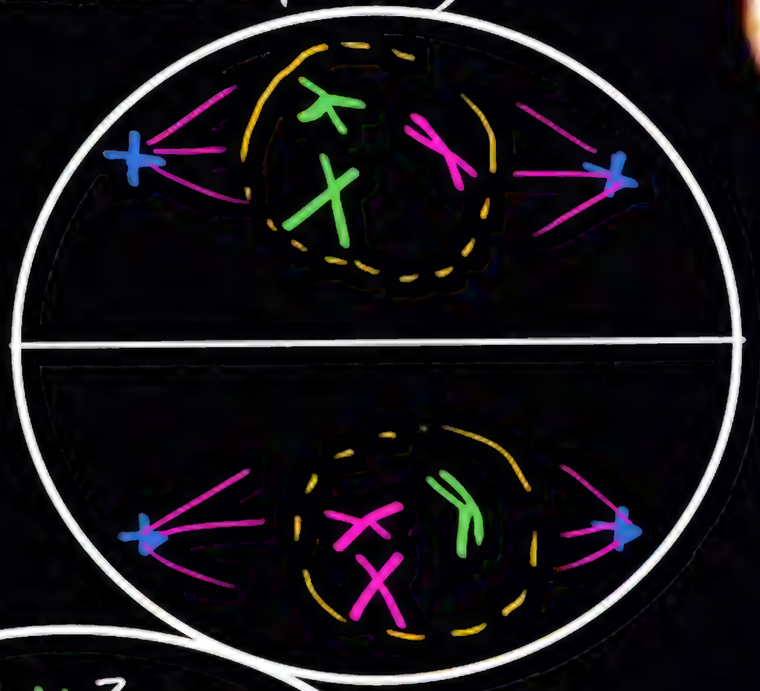


Anaphase I: The homologous chromosomes separate while sister chromatids remain associated at their centromeres (Figure 10.3).

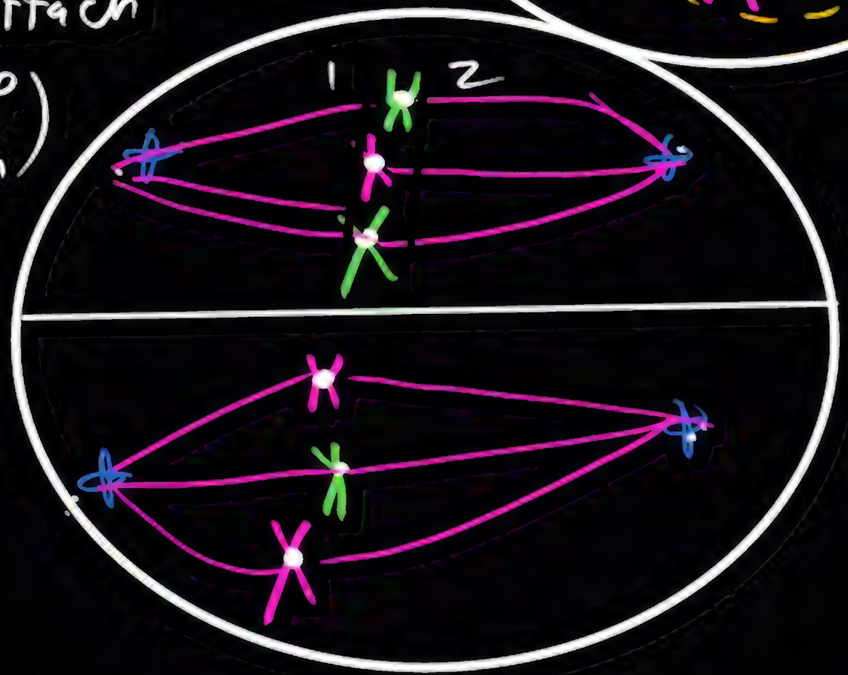
Telophase I: The nuclear membrane and nucleolus reappear, cytokinesis follows and this is called as dyad of cells (Figure 10.3). Although in many cases the chromosomes do undergo some dispersion, they do not reach the extremely extended state of the interphase nucleus. The stage between the two meiotic divisions is called interkinesis and is generally short lived. There is no replication of DNA during interkinesis. Interkinesis is followed by prophase II, a much simpler prophase than prophase I.

Meiosis II (Like Mitosis – Sister chromatids separate)

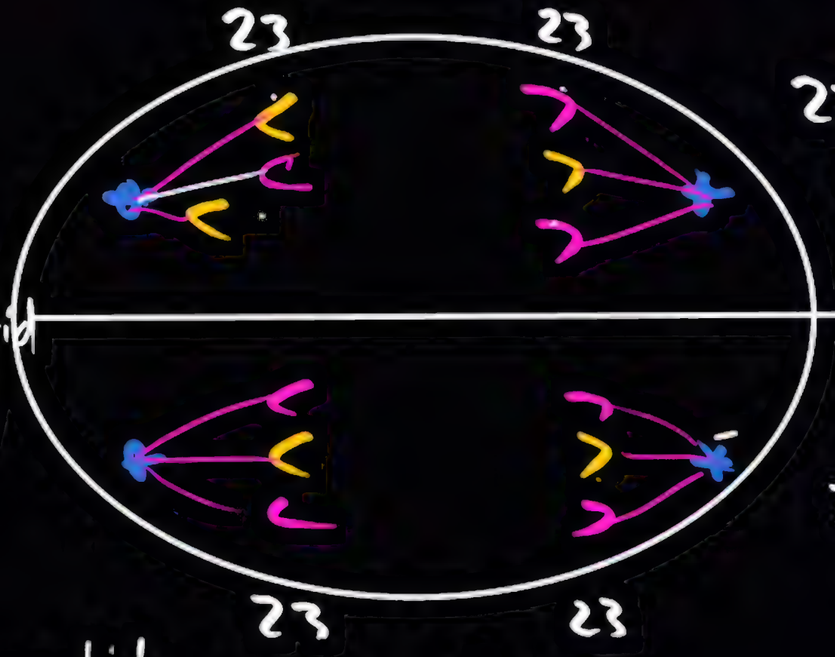
(a) Prophase II → Chromatin condense to Form chromosome
→ Centrosome move to opposite pole (Spindle Form)
→ ER, Golgi, nucleolus nuclear membrane Break



(b) Metaphase II
→ on chromosome, Spindle Fibre attach (1 chromosome = 2 spindle Fibre attach)
→ Metaphasic plate – one plate Per cell
→ Chromosome come at Equator of Spindle



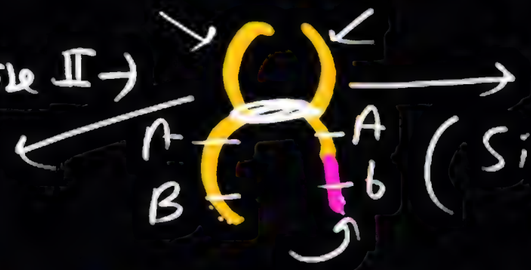
Anaphase II – Sister chromatid seperate & move to opposite pole



mitosis – Anaphase →

] sister chromatid genetically same

meiosis II – Anaphase II →

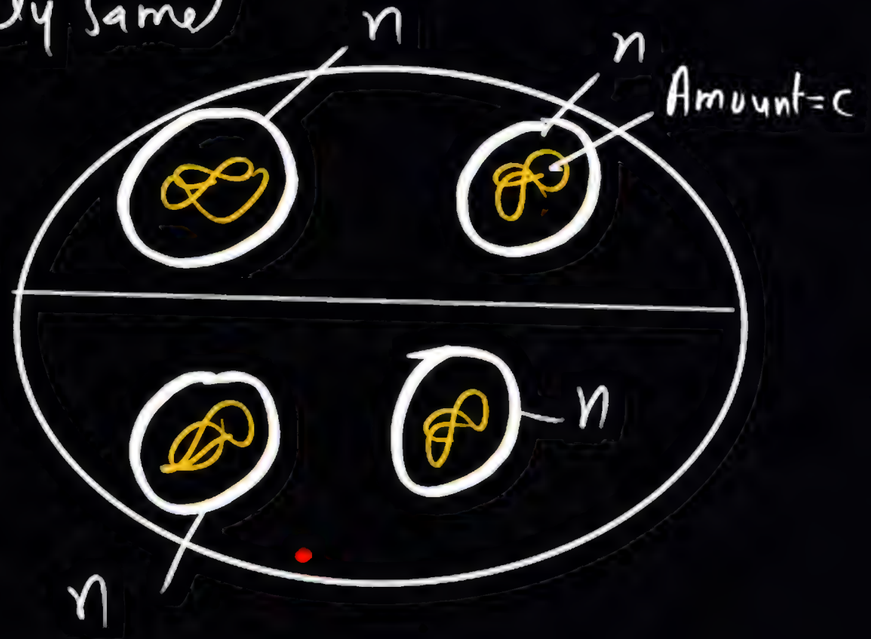


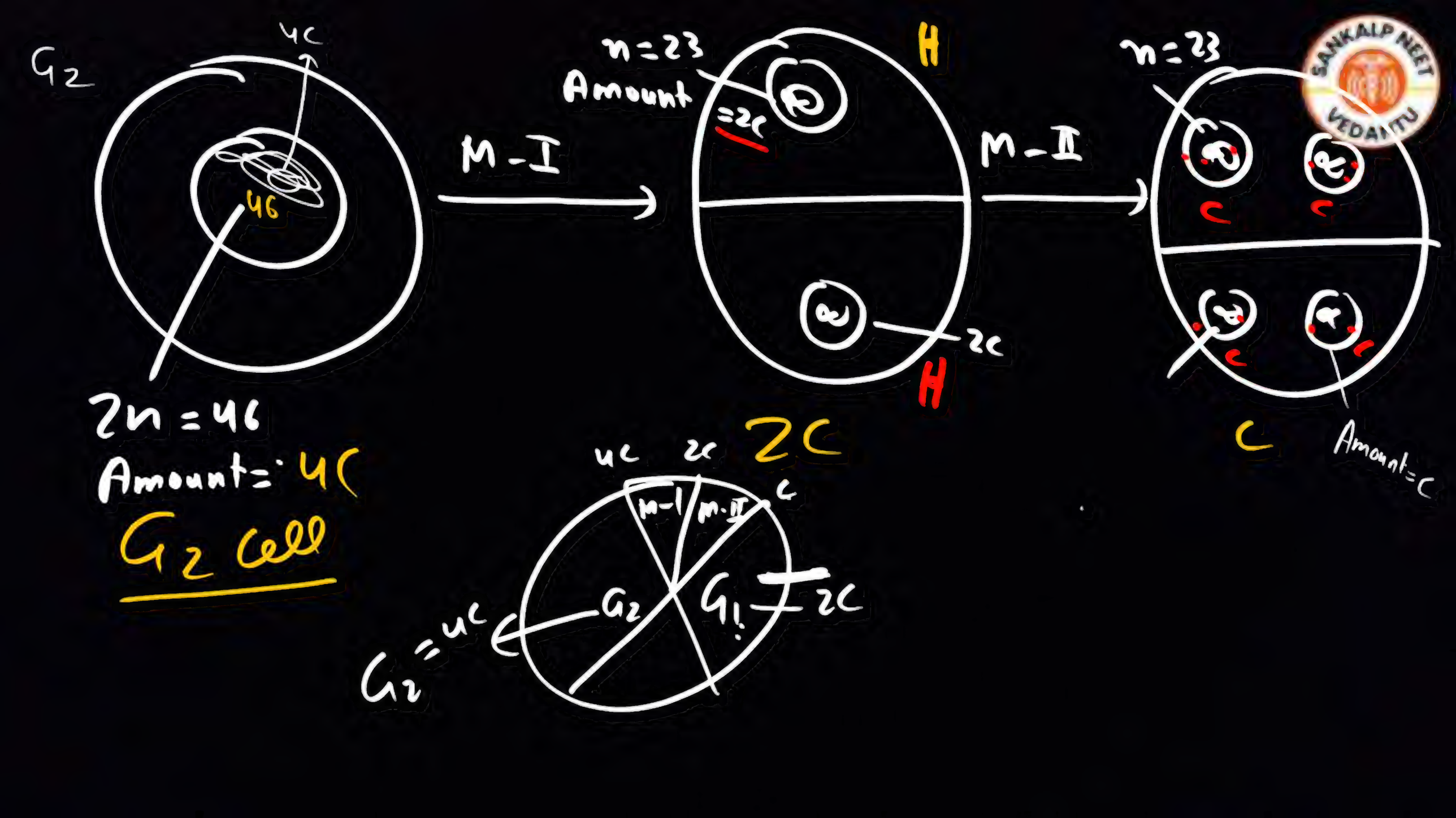
(Sister chromatids are not genetically same)

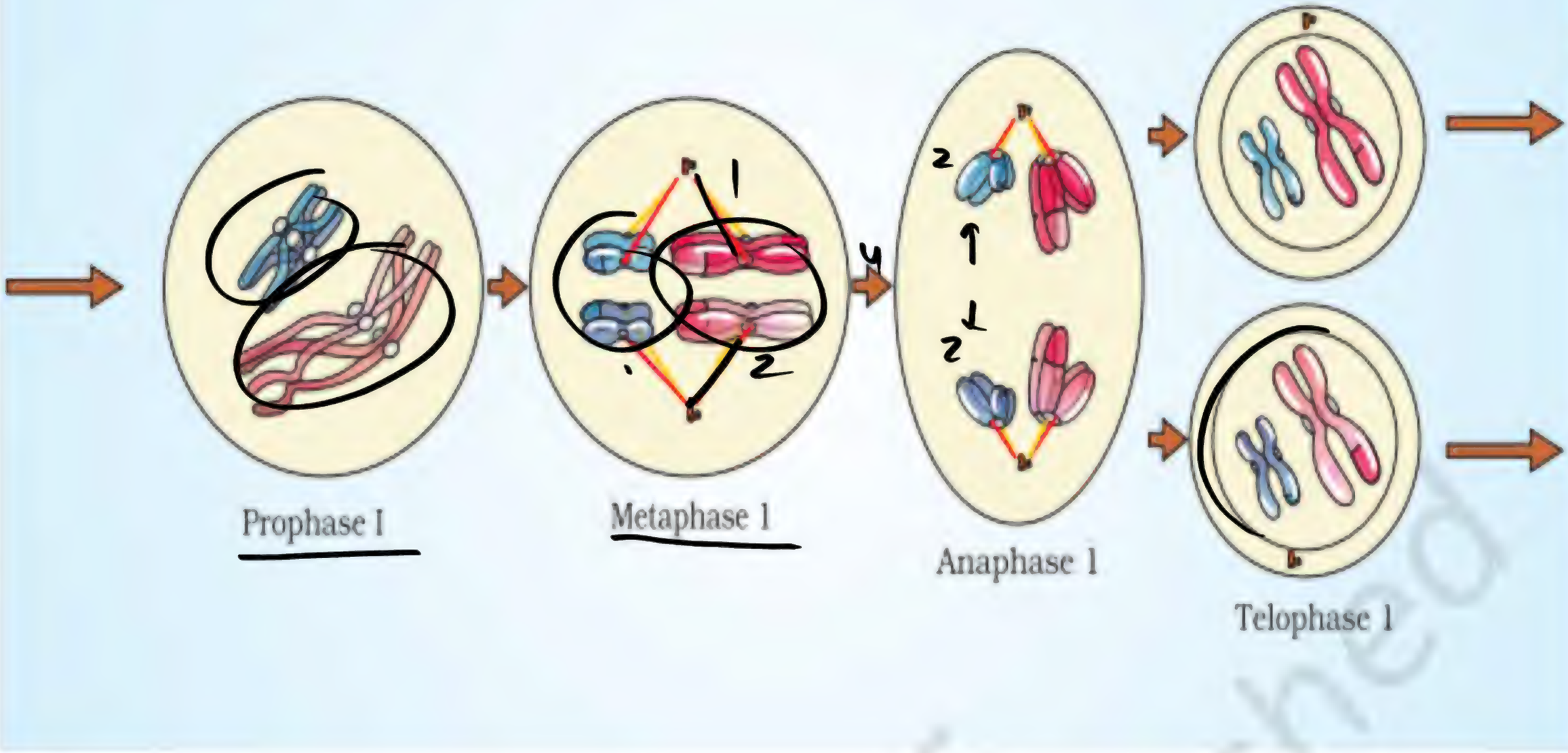
Telophase II →

→ Chromosome decondense to Form Chromatin / ER, golgi, nucleolus, nuclear membrane (Reappear)

→ Four haploid nuclei Form

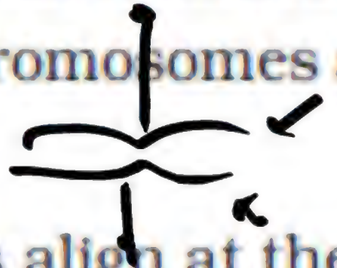



G2
4C
4C
2n = 4C
Amount = 4C
G2 cell
M-I
n=23
Amount
=2C
H
H
2C
M-II
n=23
C
C
C
C
Amount=C
2C
4C
2C
M-I
M-II
C
G2
G1
2C
G2=4C


Prophase I
Metaphase 1
Anaphase 1
Telophase 1

10.4.2 Meiosis II

Prophase II: Meiosis II is initiated immediately after cytokinesis, usually before the chromosomes have fully elongated. In contrast to meiosis I, meiosis II resembles a normal mitosis. The nuclear membrane disappears by the end of prophase II (Figure 10.4). The chromosomes again become compact.



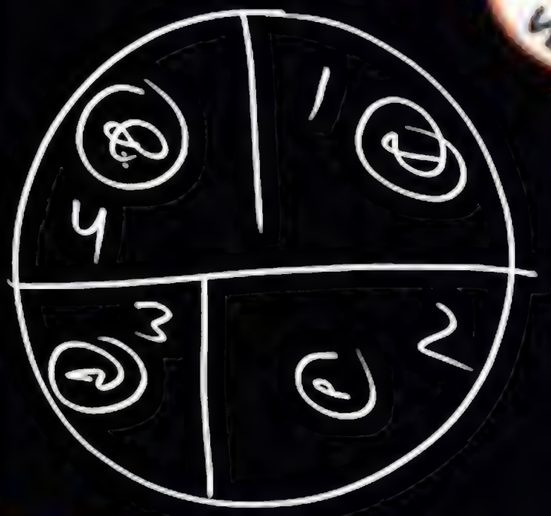
Metaphase II: At this stage the chromosomes align at the equator and the microtubules from opposite poles of the spindle get attached to the kinetochores (Figure 10.4) of sister chromatids.

Anaphase II: It begins with the simultaneous splitting of the centromere of each chromosome (which was holding the sister chromatids together), allowing them to move toward opposite poles of the cell (Figure 10.4) by shortening of microtubules attached to kinetochores.

Telophase II: Meiosis ends with telophase II, in which the two groups of chromosomes once again get enclosed by a nuclear envelope; cytokinesis follows resulting in the formation of tetrad of cells i.e., four haploid daughter cells (Figure 10.4).

10.5 Significance of Meiosis

Meiosis is the mechanism by which conservation of specific chromosome number of each species is achieved across generations in sexually reproducing organisms, even though the process, per se, paradoxically, results in reduction of chromosome number by half. It also increases the genetic variability in the population of organisms from one generation to the next. Variations are very important for the process of evolution.



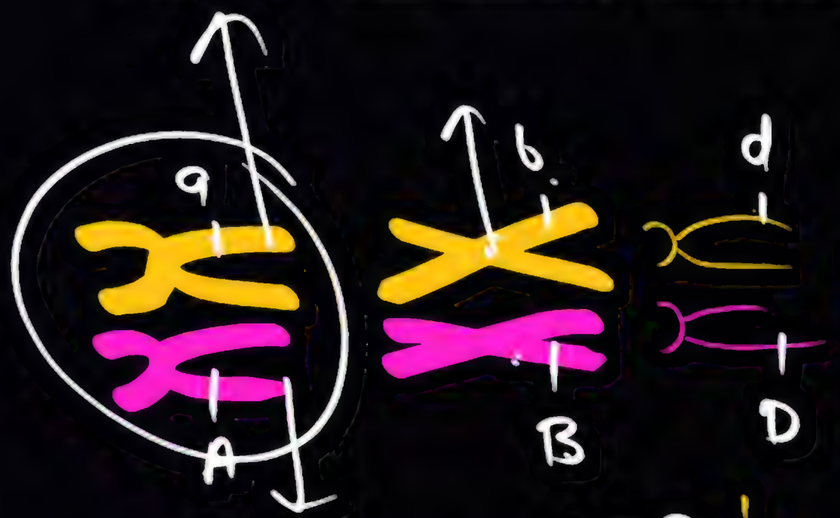
Significance of Meiosis

① - Meiosis or Reductional Division ⟶ Chromosome decrease
So that ⟶ Chromosome number of species constant
(Because Fusion of cell → Chromosome no. increase)
(Fertilization)

② It Give Variation ⟶ ① Crossing over – Sister chromatid non identical

② Anaphase - I → Different combination From

How variation come in Anaphase I



(8 type gamete)

$2n=6 \Rightarrow$ 3 pair $= 2^3 = 8$ combination

gamete = (3) — Chromosome

A B
A b

→ A B D 1
A B d 2
A b D 3
A b d 4

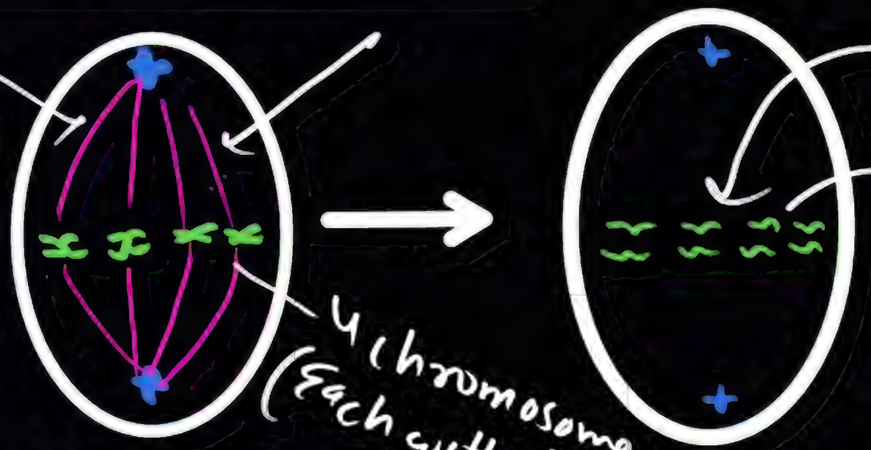
Male → 2^{23} → Combination = type gametes

Female $= 2^{23}$ type gamete)

a B
a b

a B D 5
a B d 6
a b D 7
a b d 8

What is Polyploidy → Occur in Mitosis → Sister chromatid seperate ↳ Remain same cell



8 chromosome
Sister chromatid Seperate
∄ number → Double

- normally Spindle Fibre seperate Sister chromatid
- Chemical — Colchicine
(Prevent Spindle Fibre assembly in metaphase)

note - In polyploidy APC work normally But spindle Absent

What is APC

End of Metaphase (Start of Anaphase) → APC Active

→ Cohesin protein Keep sister Chromatid together

→ APC - Enzyme complex (Anaphase Promoting complex) → Dissolve Cohesin → Sister chromatid seperate

Note - If APC is not Functional Sister chromatid Remain attach Each chromosome → two chromatid
Condition - Polyteny

Spindle pull to opposite pole.

DOPA-02

Q1 Not true for M-phase
(a) Part of cell cycle (b) nuclear membrane Break (c) Chromosome in cytoplasm (d) DNA Syn. (S-phase)

Q2 Chromosome inside cytoplasm in
(a) Prophase (b) Metaphase (c) Anaphase (d) Telophase

Q3 Sister chromatids get separated in
(a) Cytokinesis (b) Karyokinesis (c) Anaphase (d) Metaphase

Q4 Kinetochore is located on (centromere)
(a) Primary constriction (b) telomere (c) Chromatid (d) all

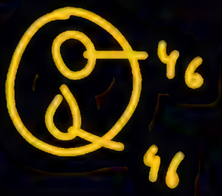
Q5 Spindle Fibre is made up
(a) Protein (b) lipid (c) Nucleic Acid (d) all

Q6 Chromosome loose identity in
(a) Anaphase (b) telophase (c) Metaphase (d) Prophase

Q7 Chromosome condensation Start in
(a) Prophase (b) Metaphase (c) Telophase (d) Anaphase

P – 46 ✓
M – 46 ✓
A → 46 | 46
T

Q8 Chromosome number get Double in ____ phase of (Caryokinesis)
(a) Prophase (b) Metaphase (c) Anaphase (d) telophase



Q9 Nuclear membrane Disappear in
(a) Prophase (b) Metaphase (c) telophase (d) Anaphase

Q10 Chromosome move Away From spindle Equator
(a) Prophase (b) Metaphase (c) telophase (d) Anaphase

MANTHAN NEET 2025

SANKALP NEET VEDANTU

Biological Classification

lecture – 01

Botany

TARUN SIR

Topics

no. of Questions → 3 Q

5. Classification – Kingdom →

1. Monera
2. Protista
3. Fungi

4. virus viroid, prions, Mycorrhizae, lichens

Today's Goal

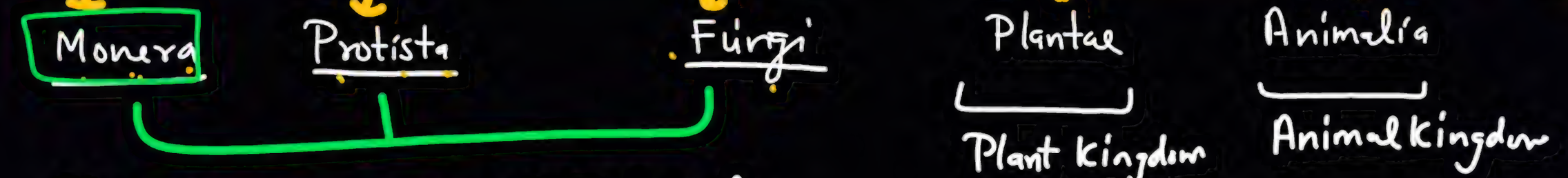
Monera

what is Diversity

→ Different type of organism (species) known as Diversity

Five Kingdom classification

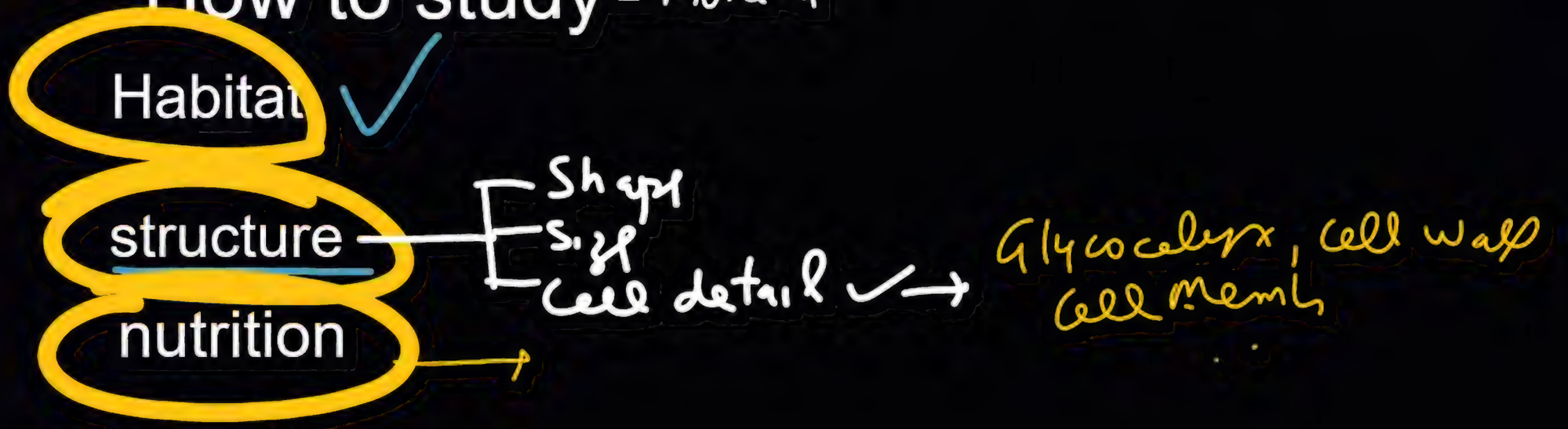
three Kingdom → Study in Biological Classification



We study topics

(a) Habitat →
(b) Structure →
(c) Nutrition →
(d) Reproduction →
(e) Classification/Importance →

How to study - monera



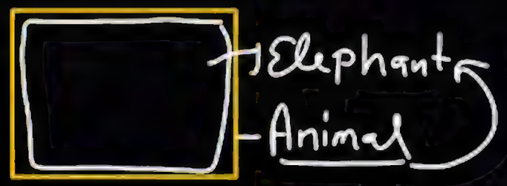
Reproduction

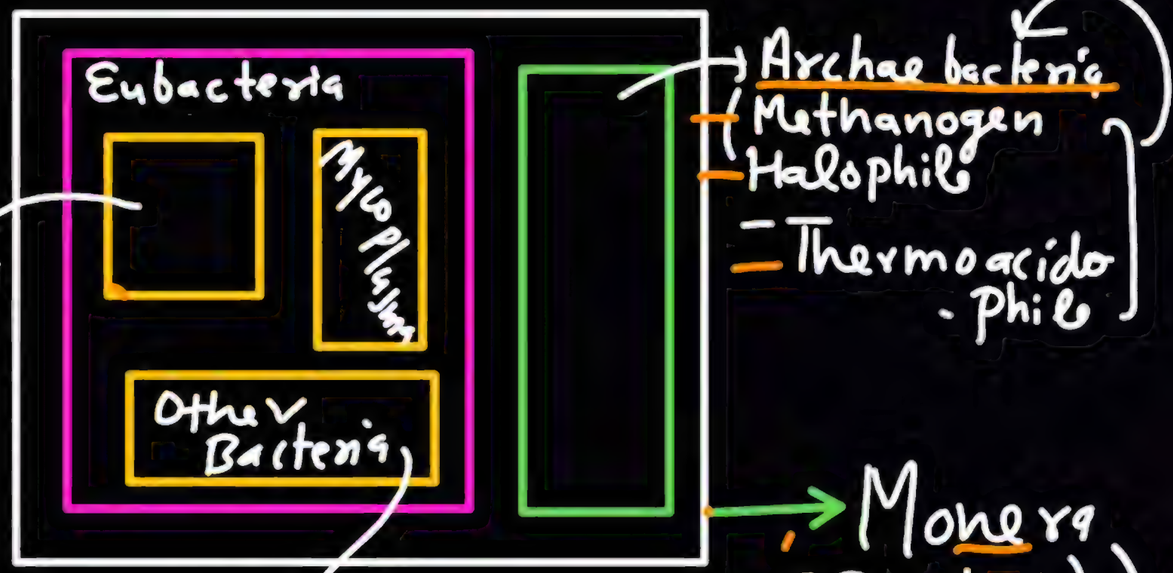
Classification

importance

I Basics of Monera →

- Monera is a Kingdom (Very large Group)
- Bacteria is sole (अकेला) member of Monera [all Moneras have prokaryotic cell]
- Cell type – Prokaryotic cell
- Only Unicellular organism





– Monera (Bacteria – Prokaryotic)

Cyanobacteria

Eubacteria — Archaebacteria

- Cyanobacteria
- Mycoplasma
- Other Bacteria

E.coli

Q Nucleoid present in
(a) Cyanobacteria (b) Monera (c) Methanogen (d) All

II Habitat

→ Cosmopolitan – Found Everywhere — Air, water, soil]
(हर जगह)

→ Some unusual Habitat – Conditions Difficult .

(a) Hot spring (b) deep sea (c) Desert (d) Salty water]
(Pressure high)

(e) Gut (Alimentary canal) (f) Some are parasitic (g) Snow
(low temp.)

Stomach → cow → Part Rumen (Methanogen)

M.O - Microorganism → Fungi, Protists, Bacteria

2.1 KINGDOM MONERA

Bacteria are the sole members of the Kingdom Monera. They are the most abundant micro-organisms. Bacteria occur almost everywhere. Hundreds of bacteria are present in a handful of soil. They also live in extreme habitats such as hot springs, deserts, snow and deep oceans where very few other life forms can survive. Many of them live in or on other organisms as parasites.

II Structure of Monera

(We need to study)

→ Monera = Prokaryotic cell → Cell detail (Chp-8 study)

→ Size of Bacteria → 2-5 µm (Mycoplasma - 0.3, PPLO - 0.1)

→ Shape

Monera/Bacteria → Classified into Four Group - on the Basis of shape

(a) Spherical → Coccus → ○ (Cocci - plural)

(b) Rod shape - Bacillus → ⬭ (Bacilli) - many

(c) Comma shape →) - Vibrium (single), many - Vibrio

(d) Spiral → Spirillium (Spirillia) - many

Which is odd

(a) Bacillus

(b) Coccus

(c) Vibrio ✓

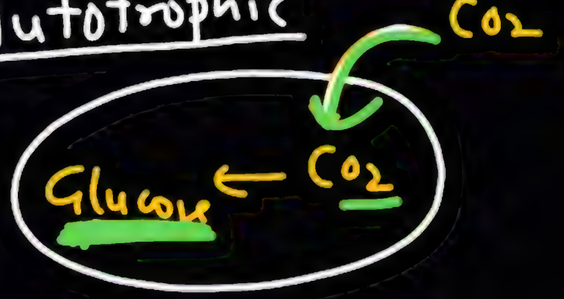
(d) Spirillium

Bacteria are grouped under four categories based on their shape: the spherical Coccus (pl.: cocci), the rod-shaped Bacillus (pl.: bacilli), the comma-shaped Vibrium (pl.: vibrio) and the spiral Spirillum (pl.: spirilla) (Figure 2.1).

III Nutrition

- It is mode of obtaining Food
- Nutrition is Basicelly of two type → (a) Autotrophic (b) Heterotrophic

Autotrophic



Autotrophic

- Inorganic CO_2 Enter into cell
  Convert into organic Glucose

$6CO_2 \longrightarrow C_6H_{12}O_6$ (Reduction)

- Reduction Require - Energy ①
  → Source of Hydrogen ②

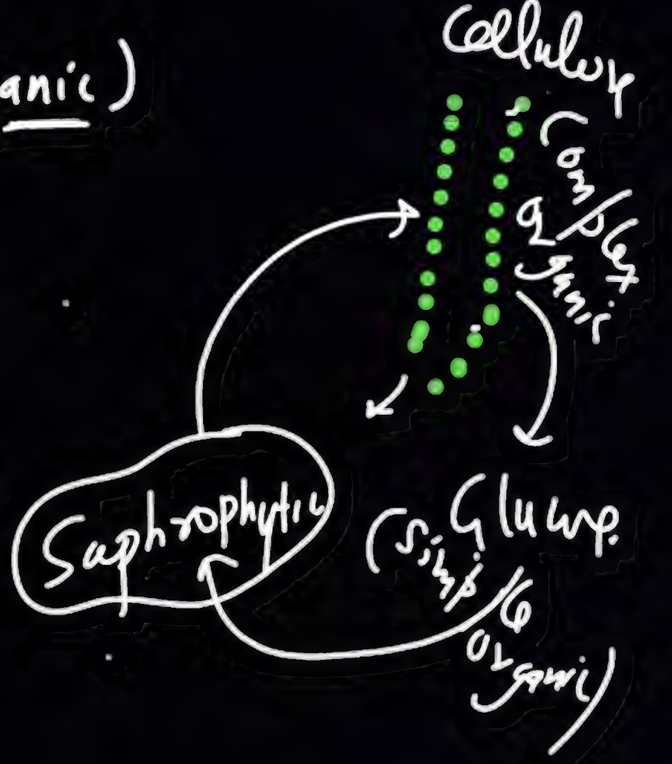
Heterotrophic

Heterotrophic → obtain organic From outside Glucose

CO_2 → Inorganic
Glucose - organic

- Obtain Glucose (organic) From outside

Three type
(a) Saprophytic
(b) Parasitic
(c) Symbiotic



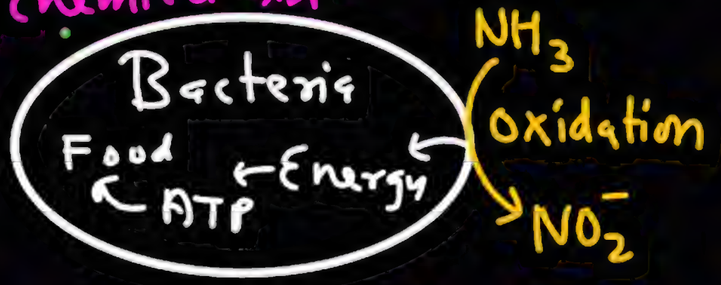
Autotrophic nutrition in Monera

- CO_2 Enter → Convert into Glucose
- Two Requirement → (a) Energy (b) Source of H

On the Basis of Source of Energy (two type of nutrition)

I Chemosynthetic (Chemo autotroph)

Energy chemical Rxn



- Outside Bacterial cell Oxidation of inorganic Compound occur → Energy From
- Energy give ATP
  - than Food Form

Example – Chemoautotroph

Nitrogen cycle

oxidation

- NH_4 —(Nitrosomonas / Nitrococcus)→ NO_2^-
- NO_2^- —(Nitrobacter)→ NO_3^-

Nitrification

Above 3 bacteria Example of Chemoautotroph

note – Pigment Absent
– N, S, P, Fe – Cycling By (Chemoautotroph)

Photo autotrophic

- Use sunlight ✓
- Pigments present ✓
  - Oxygenic
  - Anoxygenic

Nutrition

Autotrophic

(Energy From chemical Rxn)

Chemosynthetic

- Oxidation inorganic (outside cell)
- P, S, N, Fe - Cyling

Ex - Nitrosomonas
- Nitrococcus
- Nitrobacter

(From Sunlight)

Photosynthetic (Pigment)

oxygenic → Produce O_2

- Use Sunlight ✓
- Break H_2O produce O_2
- Pigment - Chlorophyll a

Ex - Cyanobacteria (Group)
- Nostoc, Anabena
Oscillatoria, Spirulina

Anoxygenic

- Use Sunlight ✓
- Pigment present (not chlorophyll.)

→ H_2O not Break, O_2 not produce

→ Hydrogen can come From H_2S or other Compound

Pigment - Green - Bacteriophyll ✓✓
Purple - Bacterio purpurin ✓

heterotrophic

(Saprophytic, Symbiotic
Paratic

H_2O
H_2S

- Green Surfur bacteria (Bacteriophyll, H_2S Break → By Product Sulfur
- Purple Sulfur Bacteria
- Green non-sulfur Bacteria
- Purple non-Sulfur Bacteria

note - Plant Kingdom
Cyanobacteria
Diatom, Euglenoids
Dinoflagellates - Chl a

(a) only S-I correct (b) only S-II correct (c) Both correct (d) Both wrong

Q1 S-I All Autotrophic have chlorophyll ✗

S-II All photoautotrophic have chlorophyll ✗

↳ Anoxygenic

Q2 S-I Nel photoautotrophic have pigment ✓

S-II Nostoc & Anabena have chla ✓

Q3 Which is not oxygenic

(a) Pinus (b) Nostoc (c) Fern (d) Purple sulfur bacteria

↓

Cyanobacteria

Plant Kingdom

Nutrition

Autotrophic

- Chemosynthetic (Chemical Rxn)
- Photosynthetic (Sunlight)
  - oxygenic
    - Chlq, H_2O Break
    - O_2 produce
    - Cyanobacteria
  - Anoxygenic
    - Green Sulfur bacteria
    - Purple sulfur bacteria
    - Green non-sulfur Bacteria
    - Purple non-Sulfur Bacteria

[heterotrophic]

(a) Saprophytic – Absorb organic From outside
- Ex- lactobacillus – Curd making ✓
- Antibiotic producing Bacteria ✓
- N_2 Fix Bacteria ✓

(b) Parasitic – Parasites on Plant or Animal
- Typhoid – Salmonella typhi
- Cholera – Vibrio cholerae
- Tuberculosis – Mycobacterium

For Animals

Disease in plant – Citrus canker – By Bacteria (Xanthomonas citri)

(c) Symbiotic Bacteria → obtain nutrition & also help

(Pre)

Some N_2 Fixing Bacteria ⟶ Ex-Rhizobium - Fix N_2 → Leguminous plant

Frankia - Fix N_2 - Non-leguminous plant (Ex-Alnus Plant)

note → ① Heterotrophic Bacteria > Autotrophic

② Saprophytic is maximum in number

DOPA -01 - Biological Classification

Q1 Which is not habitat of Monera
(a) thermal spring (b) deep sea (c) inside prions (d) inside Gut

Q2 Not true About Monera
(a) Fast Multiply (b) Mitosis occur (c) Chla can present (d) Can be symbiotic

Q3 Sole member of Monera is
(a) Cyanobacteria (b) Bacteria (c) Eubacteria (d) alp

Q4 Member of Monera
(a) Bacteria (b) Methanogen (c) Archaebacteria (d) all

Q5 Nutrition in nostoc
(a) Autotrophic (b) Oxygenic (c) Photosynthetic (d) all

(a) S-I correct (b) S-II correct (c) Both Correct (d) Both wrong

Q6 S-I Nucleoid present in Methanogen
S-II Cell wall present in Mycoplasma

Q7 S-I Nitrosomonas is chemoautroph Bacteria
S-II Chemoautotrooph not have pigment

Q8 - S-I - Chl a present in Nostoc
S-II Lactobaccilus is Saprophytic Bacteria

Q9 - S-I Most Abundant Micro organism is Bacteria
S-II Most Abundant Bacteria is Saprophytic

Q10 S-I Chemosynthetic bacteria oxidise inorganic compound
S-II Organic Food Absorb By Saprophytic & Parasitic

MANTHAN NEET 2025

SANKALP NEET VEDANTU

Biological Classification

lecture – 02

Botany

TARUN SIR

Topics

no. of Questions → 30 Q

5. Classification – Kingdom

1. Monera
2. Protista
3. Fungi

4. virus viroid, prions, Mycorrhizae, lichens

cell theory

Today's Goal

Monera

cell theory

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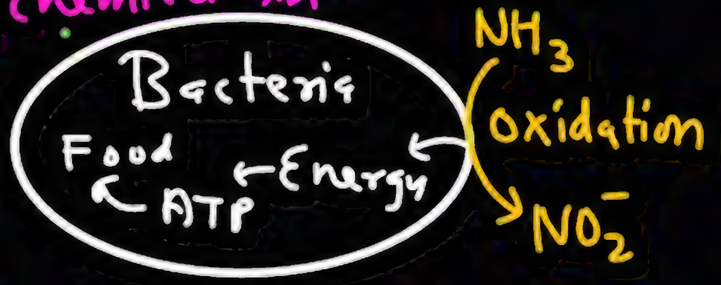
On the Basis of Source of Energy (two type of nutrition)

I Chemosynthetic (Chemo autotroph)

Energy chemical Rxn



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→ Nitrification

Above 3 bacteria Example of Chemoautotroph

note – Pigment Absent
– N, S, P, Fe – Cycling By (Chemoautotroph)

Photo autotrophic

- Use sunlight ✓
- Pigments present ✓
  - Oxygenic
  - Anoxygenic

cell theory

Nutrition

Autotrophic

(Energy From chemical Rxn)

Chemosynthetic

- Oxidation inorganic (outside cell)
- P, S, N, Fe - Cyling

Ex - Nitrosomonas
- Nitrococcus
- Nitrobacter

(From Sunlight)

Photosynthetic

(Pigment)

oxygenic

Produce O_2 ✓

- Use Sunlight
- Break H_2O produce O_2
- Pigment - Chlorophyll a

Ex - Cyanobacteria (Group)
- Nostoc, Anabena
Oscillatoria, Spirulina

Anoxygenic

- Use sunlight ✓
- Pigment present (not chlorophyll.)

→ H_2O not Break, O_2 not produce

→ Hydrogen can come From H_2S or other Compound

Pigment - Green - Bacteriophyll ✓✓

Purple - Bacterio purpurin ✓

heterotrophic

(Saprophytic, Symbiotic Parasitic

H_2O / H_2S

- Green Surfur bacteria (Bacteriophyll, H_2S Break → By Product Sulfur)
- Purple Sulfur Bacteria
- Green non-sulfur Bacteria
- Purple non-Sulfur Bacteria

note - Plant Kingdom
Cyanobacteria
Diatom, Euglenoids
Dinoflagellates - Chlg

cell theory

(a) only S-I correct (b) only S-II correct (c) Both correct (d) Both wrong

Q1 S-I All Autotrophic have chlorophyll ✗

S-II All photoautotrophic have chlorophyll ✗

↳ Anoxygenic

Q2 S-I Red photoautotrophic have pigment ✓

S-II Nostoc & Anabena have chla ✓

Q3 Which is not oxygenic

(a) Pinus (b) Nostoc (c) Fern (d) Purple sulfur bacteria

Nostoc → Cyanobacteria

Fern → Plant Kingdom

cell theory

Nutrition

Autotrophic

- Chemosynthetic (Chemical Rxn)
- Photosynthetic (Sunlight)
  - oxygenic
    - Chlq, H_2O Break
    - O_2 produce
    - Cyanobacteria
  - Anoxygenic
    - Green Sulfur bacteria
    - Purple sulfur bacteria
    - Green non-sulfur Bacteria
    - Purple non-sulfur Bacteria

[heterotrophic]

(a) Saprophytic – Absorb organic From outside
- Ex – lactobacillus – Curd making ✓
- Antibiotic producing Bacteria ✓
- N_2 Fix Bacteria ✓

(b) Parasitic – Parasites on plant or Animal
- Typhoid – Salmonella typhi
- Cholera – Vibrio cholerae
- Tuberculosis – Mycobacterium

For Animals

Disease in plant – Citrus canker – By Bacteria (Xanthomonas citri)

(c) Symbiotic Bacteria → obtain nutrition & also help

(Pre)

Some N_2 Fixing Bacteria ⟶ Ex - Rhizobium - Fix N_2 → Leguminous plant

Frankia - Fix N_2 - Non-leguminous plant

(Ex - Alnus Plant)

note ⟶ ① Heterotrophic Bacteria > Autotrophic

② Saprophytic is maximum in number

DOPA -01- Biological Classification

Q1 Which is not habitat of Monera
(a) thermal spring (b) deep sea (c) inside prions (d) inside Gut

Q2 Not true About Monera
(a) Fast Multiply (b) Mitosis occur (c) Chla can present (d) Can be symbiotic

Q3 Sole member of Monera is
(a) Cyanobacteria (b) Bacteria (c) Eubacteria (d) alp

Q4 Member of Monera
(a) Bacteria (b) Methanogen (c) Archaebacteria (d) all

Q5 Nutrition in nostoc
(a) Autotrophic (b) Oxygenic (c) Photosynthetic (d) all

(a) S-I correct (b) S-II correct (c) Both Correct (d) Both wrong

Q6 S-I Nucleoid present in Methanogen ✓
S-II Cell wall present in Mycoplasma ✗ a

Q7 S-I Nitrosomonas is chemoautroph Bacteria ✓
S-II Chemoautotroph not have pigment ✓ (c)

Q8 - S-I - Chl a present in Nostoc ✓ (c)
S-II Lactobaccilus is Saprophytic Bacteria ✓

Q9 - S-I Most Abundant Micro organism is Bacteria ✓
S-II Most Abundant Bacteria is Saprophytic ✓ c

Q10 S-I Chemosynthetic bacteria oxidise inorganic compound ✓
S-II Organic Food Absorb By Saprophytic & Parasitic ✓ c

Though the bacterial structure is very simple, they are very complex in behaviour. Compared to many other organisms, bacteria as a group show the most extensive metabolic diversity. Some of the bacteria are autotrophic, i.e., they synthesise their own food from inorganic substrates. They may be photosynthetic autotrophic or chemosynthetic autotrophic. The vast majority of bacteria are heterotrophs, i.e., they depend on other organisms or on dead organic matter for food.

Maximum type

Saprophytic

Parasitic / Symbiotic

Five kingdom classification

Monera

1 - Chemosynthetic
2 - Anoxygenic
3 - Oxygenic
4 - Saprophytic
5 - Parasitic
6 - Symbiotic

Protista

1 Oxygenic
2 Saprophytic
3 Parasitic
4 Symbiotic

Fungi

Saprophytic
Parasitic
Symbiotic

Plantae

Oxygenic

- Chla
- H2O Bvas

Animalia

- Saprophytic
- Holozoic

Q1 Which Kingdom have Chl a

(a) Monera (b) Protista (c) Plantae (d) all

Q2 Chemosynthetic nutrition

(a) only Monera (b) Monera + Protista (c) Only Protista (d) Monera + Fungi

Though the bacterial structure is very simple, they are very complex in behaviour. Compared to many other organisms, bacteria as a group show the most extensive metabolic diversity. Some of the bacteria are autotrophic, i.e., they synthesise their own food from inorganic substrates. They may be photosynthetic autotrophic or chemosynthetic autotrophic. The vast majority of bacteria are heterotrophs, i.e., they depend on other organisms or on dead organic matter for food.

2.1.1 Archaebacteria

These bacteria are special since they live in some of the most harsh habitats such as extreme salty areas (halophiles), hot springs (thermoacidophiles) and marshy areas (methanogens). Archaebacteria differ from other bacteria in having a different cell wall structure and this feature is responsible for their survival in extreme conditions. Methanogens are present in the gut of several ruminant animals such as cows and buffaloes and they are responsible for the production of methane (biogas) from the dung of these animals.

Reproduction in Monera

Reproduction – Biological process, organism of its own kind produce

In monera → Both Asexual Reproduction & Sexual Reproduction Both occur

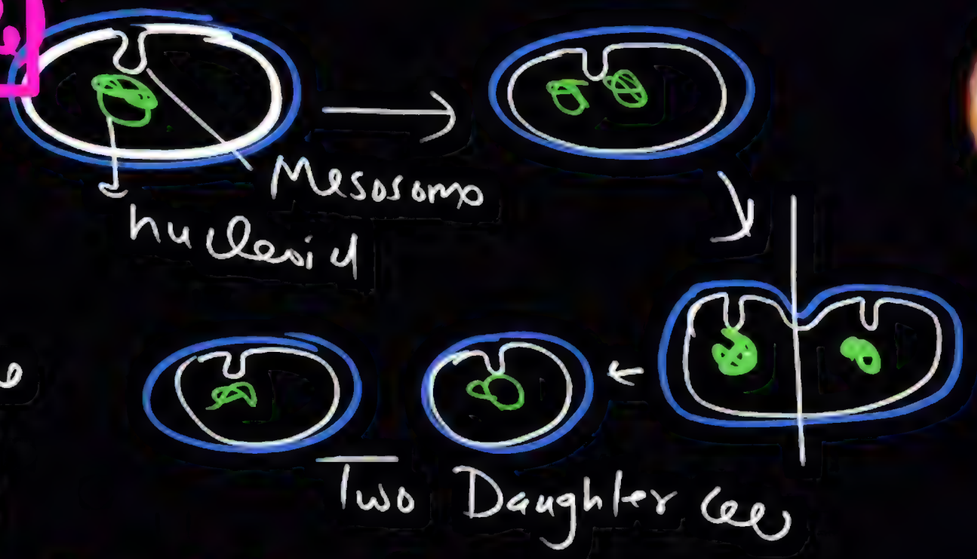
main is – Asexual Reproduction (Lower organism → Asexual Reproduction is main

Reproduction in Monera

- Asexual Reproduction (two type)
  - (a) Fission (Favorable condition) → temp. (proper) pH → optimum
  - (b) Spore Formation (unfavorable)
- Sexual Reproduction

I Binary Fission / Fissiom (Favorable)

- One Bacteria cell Divide to Form two Cell with the help of Mesosomes



- Time in which Bacterial cell number get double = Generation time

(E. coli ⟶ 20 min - generation time)

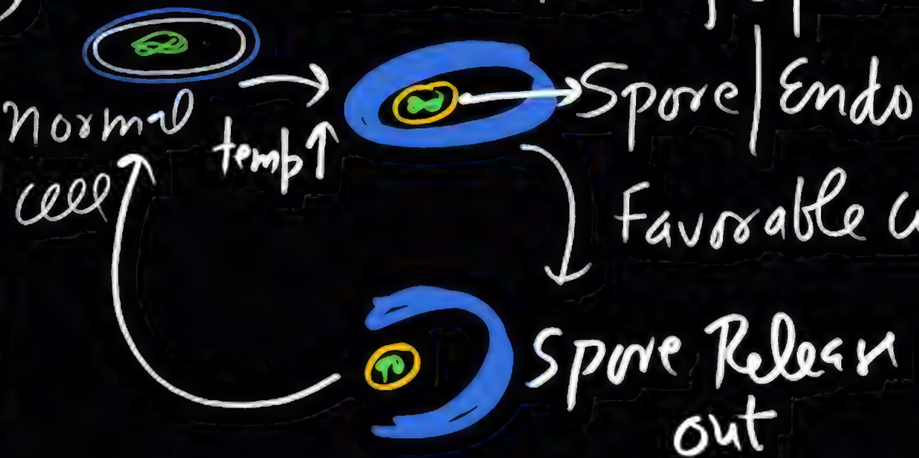
II Spore Formation (Unfavorable Condition)

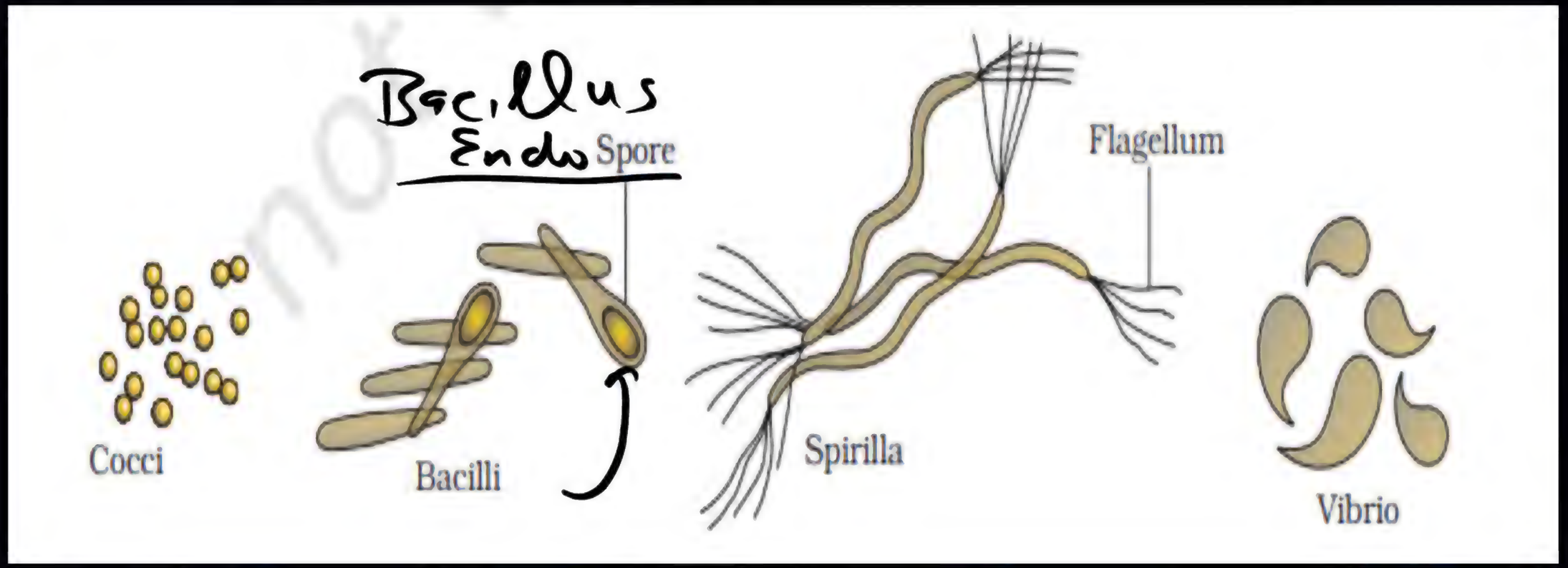
Grow Bacteria ⟶ Temp. inc (Unfavourable)

Some bacteria Survive Due to Formation of spore

→ not all Bacteria Form spore

→ Bacillus, Clostridium } Genus Form Spore




Bacillus
Endo Spore
Flagellum
Cocci
Bacilli
Spirilla
Vibrio

sexual Reproduction

- Bacteria is - Unicellular & Prokaryotic
- Gametes, Sex organ, Zygote } not Form

- Only Some primitive method of DNA tranfer occur - DNA from other Bacteria Enter into Bacterial cell
- Variation occur - Due to Entry of DNA
- Monera → Sexual Reproduct present But not true Sexual Reproduction → No - Gamete, Zygote, Meiosis, Sex organ

Three method By - which DNA Enter into Bacterial cell

1. Transformation
2. Conjugation
3. Transduction

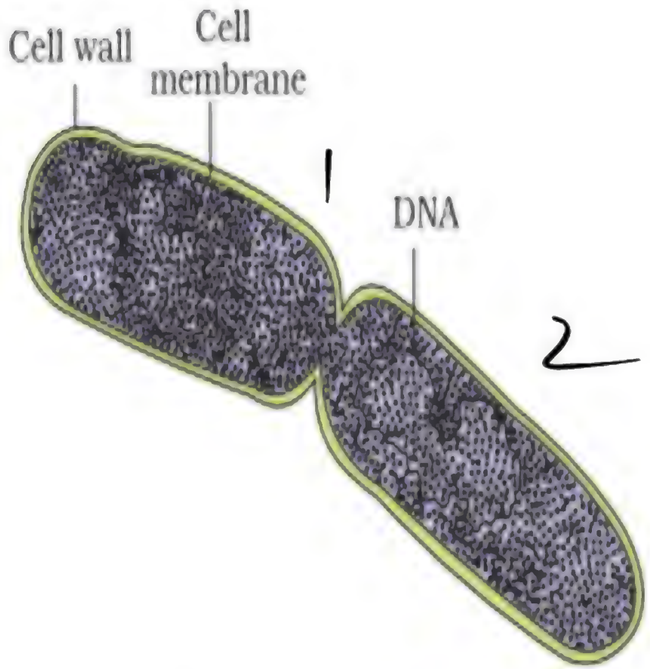


Figure 2.3 A dividing bacterium

roots, etc. Some are pathogens causing damage to human beings, crops, farm animals and pets. Cholera, typhoid, tetanus, citrus canker are well known diseases caused by different bacteria.

Bacteria reproduce mainly by fission (Figure 2.3). Sometimes, under unfavourable conditions, they produce spores. They also reproduce by a sort of sexual reproduction by adopting a primitive type of DNA transfer from one bacterium to the other.

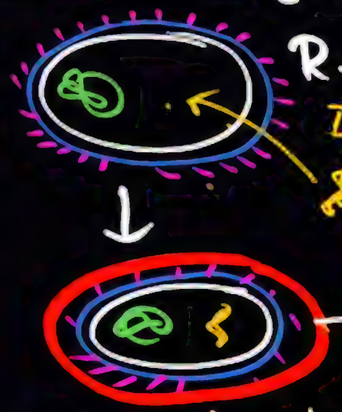
The **Mycoplasma** are organisms that completely lack a cell wall. They are the smallest living cells known and can survive without oxygen. Many mycoplasma are pathogenic in animals and plants.

Transformation

Streptococcus Bacteria

R-Strain

DNA (medium)



Extra mucus layer Form

S-Strain (Streptococcus)

→ DNA Enter From medium

Conjugation

Sex pilli

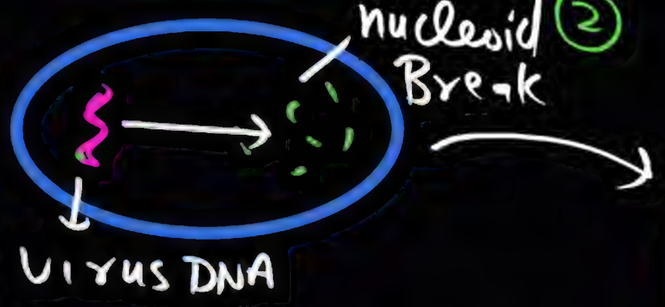
F-Plasmid

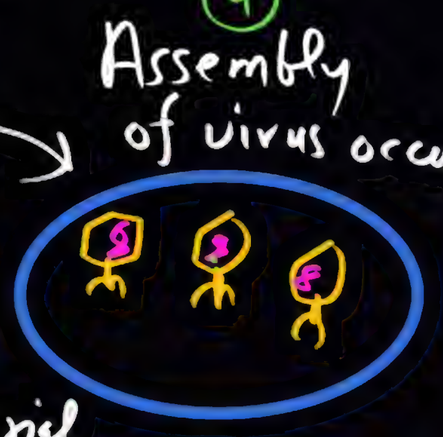
Conjugation tube (develop From sex pilli)

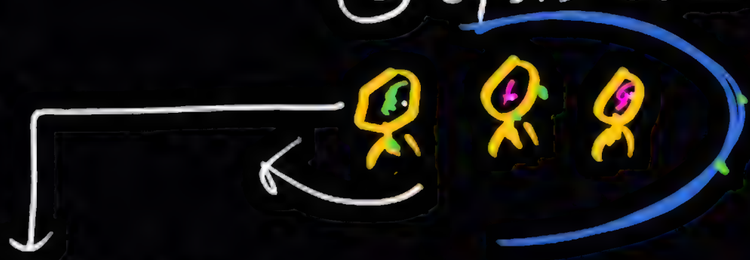
— DNA (Plasmid) move from one bacteria to Another Directly By Conjugation tube

Transduction → DNA tranfer From Virus

- Virus which Attack Bacteria - Bacteriophage
- Bacteriophage → infection cycle - Lytic cycle







[By Mistake Some virus pack DNA of Nucleoid] → [when it attack new bacteria (old Bacteria) tranfer DNA of old Bacteria ✓

Classification of Monera

Monera [Kingdom]
(Bacteria)

(two Group)

[Archaebacteria
(Primitive Bacteria)]

(Found in Harsh condition)

Examples

I Methanogen
II Halophiles
III Thermoacidophile

Eubacteria
(True Bacteria)

Example

I Cyanobacteria
II Mycoplasma
III Actinomycetes (Group
- Mycobacterium (tuberculosis)
- Streptomyces (Antibiotic)
- Frankia

(Some Feature like Fungi
So it is Bacteria But
Known as Ray Fungi

Not in syllabus

Archaebacteria

- Primitive Bacteria
- Found in - Harsh condition → High temp (80-100°C)
  PH Low (Acidic)
  Salt high
  O_2 Absent

Archaebacteria → Evolve when Entire Earth have Difficult conditions and still Exist → where these condition present)

- Difference in structure of Archaebacteria & Eubacteria (NCERT) → mainly - cell wall (Due to which Archaebacteria Survive)

Archaebacteria

(a) Cell wall present - not peptidoglycan

(b) Cell Membrane →

- Branch chain lipid
- Monolayer
- Ether linkage

(c) Some Archaebacteria have histones

(d) Introns present

Eubacteria

(a) Cell wall - Peptido Glycan

(b) Cell Membrane

- Branch chain lipid Absent
- Bilayer
- Ester linkage

note - Membrane of Eubacteria is similar to Eukaryotes

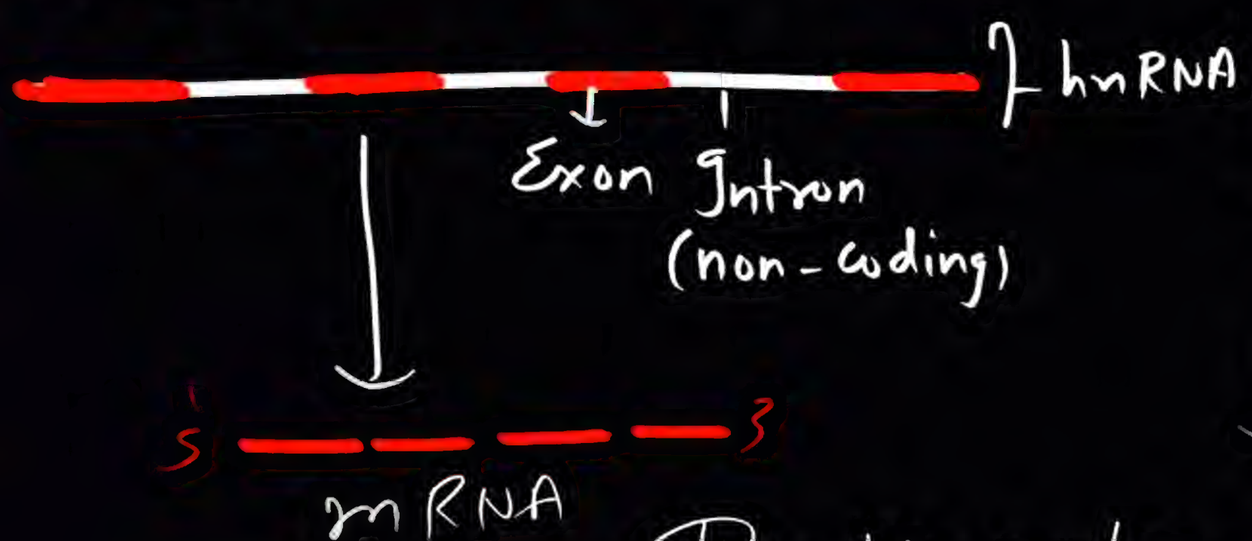
(c) Eubacteria not have Histones.

(d) Introns Absent

[Difference in 16s rRNA]

Archaebacteria → Eubacteria → Eukaryotes

(introns & Exons) (mRNA) (hnRNA) (introns & Exons)



Eukaryotes

hnRNA —modify→ mRNA

Prokaryotes – Directly mRNA Form

DOPA-02

Q1 Not true For Anabena
(a) Cyanobacteria (b) Flagella present (c) Chla (d) Oxygenic

Q2 Unfavorable Asexual Reproduction in Monera
(a) Fission (b) Conjugation (c) Spore Formation (d) all

Q3 Sexual Reproduction in monera not involve
(a) Variation (b) DNA tranfer From other Bacteria (c) Change in Phenotype (d) Meiosis

Q4 DNA tranfer From one bacteria to other By Medium
(a) Transduction (b) Tranformation (c) Conjugation (d) Fission

Q5 Most common type of Autotrophic nutrition in Monera
(a) Saprophytic (b) Parasitic (c) Symbiotic (d) none

Q6 Oxygenic nutrition occur in

(a) Plantae (b) Protista (c) Monera (d) all

Q7 Chemosynthetic nutrition present in

(a) Monera (b) Protista (c) Plantae (d) all

Q8 Archaebacteria differ From Eubacteria in

(a) nucleoid (b) cell wall (c) 70 s ribosome (d) all

Q9 Difference in Eukaryotes & Eubacteria

(a) Membrane Bound organelles (b) 80 s ribosome (c) Nucleus (d) all

Q10 Which not have peptidoglycan cell wall

(a) Methanogen (b) E. coli (c) Nostoc (d) Anabena

Type of Archaebacteria

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cell theory

cell theory

MANTHAN NEET 2025

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Biological Classification

lecture – 03

Botany

TARUN SIR

Topics

no. of Questions → 30 Q

5. Classification – Kingdom

1. Monera
2. Protista
3. Fungi

4. virus viroid, prions, Mycorrhizae, lichens

cell theory

Today's Goal

Monera

cell theory

Five kingdom classification

Monera

1 - Chemosynthetic
2 - Anoxygenic
3 - Oxygenic
4 - Saprophytic
5 - Parasitic
6 - Symbiotic

Protista

1 Oxygenic
2 Saprophytic
3 Parasitic
4 Symbiotic

Fungi

Saprophytic
Parasitic
Symbiotic

Plantae

Oxygenic

- Chla
- H_2O Byes

Animalia

- Saprophytic
- Holozoic

Q1 Which Kingdom have Chl a

(a) Monera (b) Protista (c) Plantae (d) all

Q2 Chemosynthetic nutrition

(a) only Monera (b) Monera + Protista (c) Only Protista (d) Monera + Fungi

Archaebacteria

- Primitive Bacteria
- Found in - Harsh condition → High temp (80-100°C) ↑
  PH low (Acidic) ↓
  Salt high ↑
  O_2 Absent –

Archaebacteria → Evolve when Entire Earth have Difficult conditions and still Exist → where these condition present)

- Difference in structure of Archaebacteria & Eubacteria → mainly – cell wall (Due to which Archaebacteria Survive)
  (Peptidoglycan) (NCERT)

Archaebacteria

(a) Cell wall present – not peptidoglycan

(b) Cell Membrane →

- Branch chain lipid ✓
- Monolayer ✓
- Ether linkage ✓

(c) Some Archaebacteria have histones

(d) Introns present (in RNA)

Eubacteria

(a) Cell wall – Peptido Glycan

(b) Cell Membrane

- Branch chain lipid Absent ∵
- Bilayer
- Ester linkage

note – Membrane of Eubacteria is similar to Eukaryotes

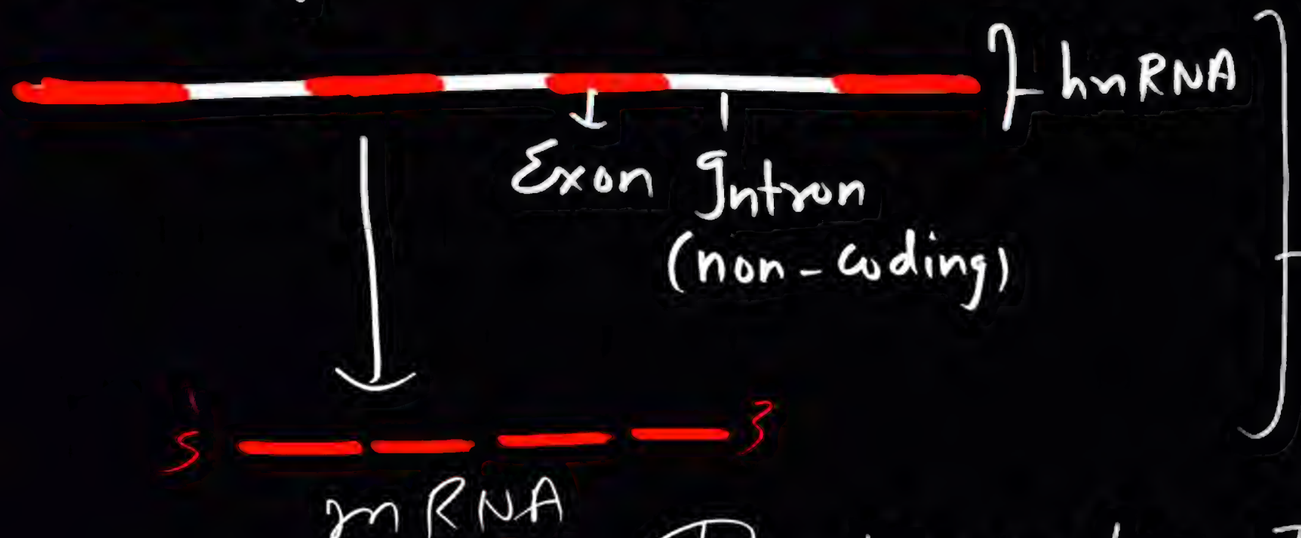
(c) Eubacteria not have Histones.

(d) Introns Absent

[Difference in 16s rRNA]

Archaebacteria → Eubacteria → Eukaryotes

(introns & Exons) (mRNA) (hnRNA) (introns & Exons)



Eukaryotes

hnRNA —modify→ mRNA

Prokaryotes – Directly mRNA Form

DOPA-02

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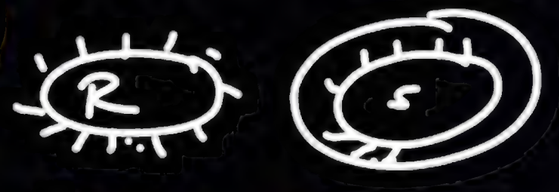

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Q10 Which not have peptidoglycan cell wall
(a) Methanogen (b) E. coli (c) Nostoc (d) Anabena

Archae

Eubacteria

Type of Archaebacteria

Obligate = compulsory
Obligate Anaerobe – live without O_2
Obligate Aerobe – live in O_2 (without O_2 kill)

(a) Methanogen (obligate anaerobe) → live without O_2 (Anaerobic) ✓
(Group) Convert CO_2 into CH_4 ✓
Found in → Marshy Area
→ gut of Ruminants (Cow & Buffalo)
Ex- Methanobacterium → Bio gas Plant
Sewage treatment Plant (Anaerobic Sludge Digester tank)

(b) Halophiles (Salt loving) → Survive high Salt conc.

(c) Thermo acido phile – Survive – Low PH = 2 (Sulfuric Acid)
high temp. – 80°C
Ex- Thermus Aquaticus (Bacteria use in Biotech)
thermostable Enzyme present.

2.1.1 Archaebacteria

hot spring ↑ temp ↑ PH ↓

These bacteria are special since they live in some of the most harsh habitats such as extreme salty areas (halophiles), hot springs (thermoacidophiles) and marshy areas (methanogens). Archaebacteria differ from other bacteria in having a different cell wall structure and this feature is responsible for their survival in extreme conditions. Methanogens are present in the gut of several ruminant animals such as cows and buffaloes and they are responsible for the production of methane (biogas) from the dung of these animals.

Eubacteria

- Similarity B/w Eubacteria & Archaebacteria → (a) Both have nucleoid
  (b) Ribosome – 70 s type

- Eubacteria (true Bacteria)
  We study Groups
  → (a) Cyanobacteria
  → (b) Mycoplasma
  (c) Actinomycetes (But it is Bacteria Ray Fungi)
  Ex- Streptomyces
  Mycobacterium } – Gram true
  Frankia

Cyanobacteria → old name - Blue green Algae

Habitat - Marine, Fresh water & terrestial

Structure :- Prokaryotic

Detail of cell

(a) Cell wall - peptidoglycan →

(b) Cell Membrane - lipid Bilayer →

(c) Flagella - Absent

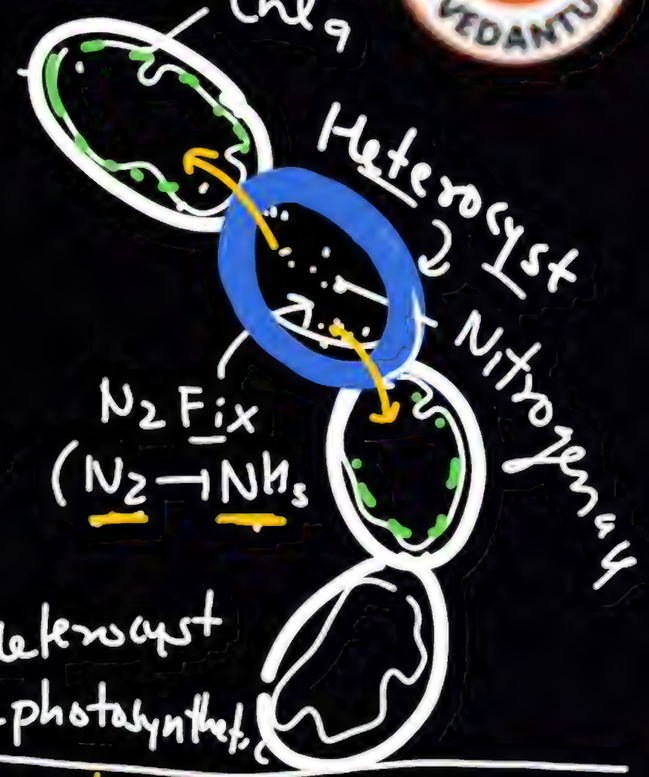
(d) Pigment → Chla → on chromatophore

↳ Oxygen produce

(e) Special structure Form to Fix N_2 - Heterocyst

(f) Ribosome - 70s

Some cyanobacteria ↓ Modified cell (Heterocyst) ↓ Fix N_2] Nitrogenase Enzyme] ↓ Not like O_2



Q Heterocyst are all Except

(a) Fix N_2 (b) Photosynthetic

(c) thick wall (d) Some Cyanobacteria

Example of cyanobacteria → Nostoc, Anabena
Spirulina, Oscilatoria

Role of Cyanobacteria

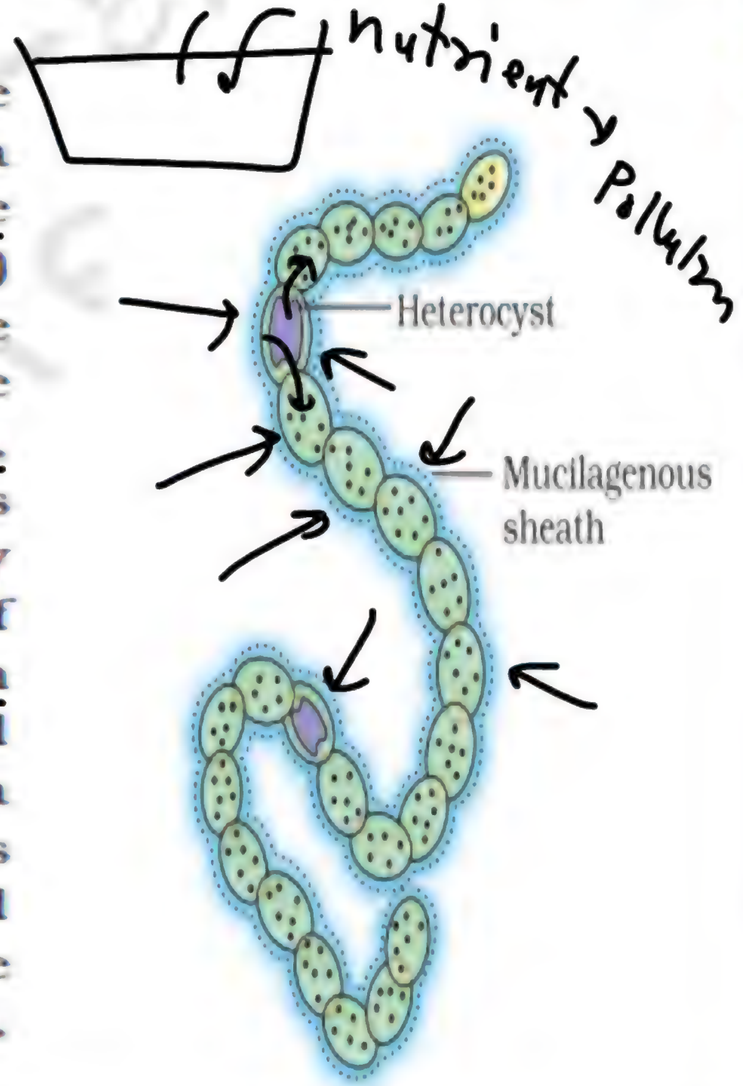
(1) N_2 Fixation (Both type) → Free living ✓
→ Symbiotic ✓

Example of symbiotic → (i) Azolla (Fern-Leaf have) Anabena
(ii) Cycas → Coralloid → Cyanobacteria
Root in cycas Line
(iii) Lichens → also have cyanobacteria

(2) Cyanobacteria develop Bloom in water → Pollution in water
(Fast Growth)

2.1.2 Eubacteria

There are thousands of different **eubacteria** or 'true bacteria'. They are characterised by the presence of a rigid cell wall, and if motile, a flagellum. The **cyanobacteria** (also referred to as blue-green algae) have chlorophyll *a* similar to green plants and are **photosynthetic autotrophs** (Figure 2.2). The cyanobacteria are unicellular, colonial or filamentous, freshwater/marine or terrestrial algae. The colonies are generally surrounded by gelatinous sheath. They often form blooms in polluted water bodies. Some of these organisms can fix atmospheric nitrogen in specialised cells called **heterocysts**, e.g., *Nostoc* and *Anabaena*. **Chemosynthetic autotrophic** bacteria oxidise various inorganic substances such as nitrates, nitrites and ammonia and use the released energy for their ATP production. They play a great role in recycling nutrients like nitrogen, phosphorous, iron and sulphur.



Mycoplasma – Group – Average Size → 0.3 µm

(PPLO → Pleuro pneumonia like organism → Size → 0.1 µm)

Feature → Smallest cell

☆ → Cell wall Absent (- Gram – ve
- Penicillin not Effective
- Shape not Fix)

→ Flagella Absent

→ nucleoid, 70 s ribosome, normal cell Membrane

Role – Can Survive without O_2 ☆ (Facultative Anaerobe)

- Pathogenic to Plants & Animals ☆ (Disease causing)

→ Saprophytic / Parasitic

① Obligate Aerobe – Kill without O_2

② Obligate Anaerobe – Kill in O_2

→ Facultative Aerobe
(They are Anaerobic But can survive in O_2)

→ Facultative Anaerobe
They are Aerobic But Can Survive in Absence of O_2

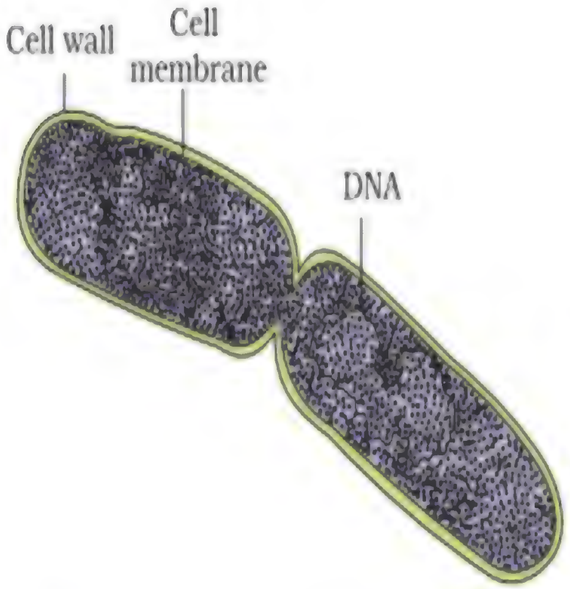


Figure 2.3 A dividing bacterium

roots, etc. Some are pathogens causing damage to human beings, crops, farm animals and pets. Cholera, typhoid, tetanus, citrus canker are well known diseases caused by different bacteria.

Bacteria reproduce mainly by fission (Figure 2.3). Sometimes, under unfavourable conditions, they produce spores. They also reproduce by a sort of sexual reproduction by adopting a primitive type of DNA transfer from one bacterium to the other.

The **Mycoplasma** are organisms that completely lack a cell wall. They are the smallest living cells known and can survive without oxygen. Many mycoplasma are pathogenic in animals and plants.

58. Oxygenic photosynthesis occurs in
(a) *Oscillatoria* (b) *Rhodospirillum*
(c) *Chlorobium* (d) *Chromatium.*

(2009)

59. Which of the following is a symbiotic nitrogen fixer? — Cyanobacteria,
(a) *Azotobacter* (b) *Frankia*
(c) *Azolla* — Plant (d) *Glomus*

(2009)

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28. Which structures perform the function of mitochondria in bacteria?
(a) Nucleoid (b) Ribosomes
(c) Cell wall (d) Mesosomes
(2014)

29. The motile bacteria are able to move by
(a) fimbriae (b) flagella
(c) cilia (d) pili.
(2014)

30. Anoxygenic photosynthesis is characteristic of
(a) *Rhodospirillum* (b) *Spirogyra*
(c) *Chlamydomonas* (d) *Ulva*.
(2014)

31. Which of the following are likely to be present in deep sea water?
(a) Blue-green algae (b) Saprophytic fungi
(c) Archaebacteria (d) Eubacteria
(NEET 2013)

32. Pigment containing membranous extensions in some cyanobacteria are
(a) pneumatophores (b) chromatophores
(c) heterocysts (d) basal bodies.
(NEET 2013)

1. Which of the following are found in extreme saline conditions?
(a) Eubacteria (b) Cyanobacteria
(c) Mycobacteria (d) Archaebacteria
(NEET 2017)

7. Methanogens belong to
(a) eubacteria (b) archaebacteria
(c) dinoflagellates (d) slime moulds.
(NEET-II 2016)

3. Which among the following are the smalle living cells, known without a definite cell wal pathogenic to plants as well as animals an can survive without oxygen?
(a) *Pseudomonas* (b) Mycoplasma
(c) *Nostoc* (d) *Bacillus*
(NEET 201

9. The primitive prokaryotes responsible for the production of biogas from the dung of ruminant animals, include the
(a) methanogens
(b) eubacteria
(c) halophiles
(d) thermoacidophiles. *(NEET-I 2016)*

10. Which one of the following statements is wrong?
(a) Eubacteria are also called false bacteria.
(b) Phycomycetes are also called algal fungi.
(c) Cyanobacteria are also called blue-green algae.
(d) Golden algae are also called desmids
(NEET-I 2016)

21. Cell wall is absent in

(a) Mycoplasma
(b) *Nostoc*
(c) *Aspergillus*
(d) *Funaria*. (2015)

Fungi
Plant

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Five Kingdom classification

Monera | Protista | Fungi | Plantae | Animalia

Monera: Prokaryotes, Unicellular

- Ribosome – 70 s
- → Membrane Bound organelle – Absent
- → Nucleoid
- → Cell Division – Fission (Primitive method of DNA transfer)

Protista: Eukaryotes, Unicellular

Ribosome → 80 s

Present

- → well defined nucleus
- → Mitosis & Fusion of gamets (Zygote)

(Reproduction – True)

Fungi, Plantae, Animalia: Eukaryotes ∃ Multicellular

Protistа

Created in three kingdom classification By - Haeckel

Basic Feature:- (a) Unicellular Eukaryotes

(b) All Feature of Eukaryotic cell ⟶ Well defined nucleus, Membrane Bound organelle, Cytoskeletal Element

(c) Main Habitat - Aquatic

(d) Boundaries of this Kingdom is not Define

(One Member Acc. to one Scientist in protista then Acc. to other it is plantae Animalia, Fungi)

- Chlamydomonas Acc. to Five Kingdom Classification, it is Protista, But some biologist believe it should be plantae

(e) They show Mitosis, gamete Formation, Fusion of cell

Zygote Formation & Meiosis

Acc. to NCERT → 5 Group in Protista

Protista

Photosynthetic Protist

(a) Chrysophytes (Diatoms, Desmids)

(b) Dinoflagellates

(c) Euglenoids

Saprophytic ←

(a) Slime moulds

Holozoic / Parasitic

(e) Protozoa

2.2 Kingdom Protista

All single-celled eukaryotes are placed under **Protista**, but the boundaries of this kingdom are not well defined. What may be 'a photosynthetic protistan' to one biologist may be 'a plant' to another. In this book we include Chrysophytes, Dinoflagellates, Euglenoids, Slime moulds and Protozoans under Protista. Members of Protista are primarily aquatic. This kingdom forms a link with the others dealing with plants, animals and fungi. Being eukaryotes, the protistan cell body contains a well defined nucleus and other membrane-bound organelles. Some have flagella or cilia. Protists reproduce asexually and sexually by a process involving cell fusion and zygote formation.

cell theory

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Biological Classification

lecture - 04

Botany

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Today's Goal

Protista

Cell theory

Classification of Protista (on the Basis of nutrition)

[Photosynthetic protist]

I Chrysophytes
II Dinoflagellates
III Euglenoids

Closer to Algae (Closer to plants)

[Saprophytic protist]

IV Slime mould

Closer to Fungi

[Predator | Parasite | Holozoic]

V Protozoa

Closer to Animalia

Q Protist which is closer to Animal cell

(a) Chrysophytes
(b) Slime moulds
~~(c) Protozoa~~
(d) Dinoflagellates

I Chrysophytes → Involve two Group — Diatoms, Desmids (Golden Algae)

Primitive

- Mainly study → Diatoms

✓ **Habitat** – Fresh water & Marine (ocean)

✓ **Structure** → Single cell Eukaryotes

(a) Diatom → cell wall – Overlapping Soap case like

– Silica present — Indestructible

– Silica (SiO_2) → Indestructible (no one can destroy)

– cell wall (thin)

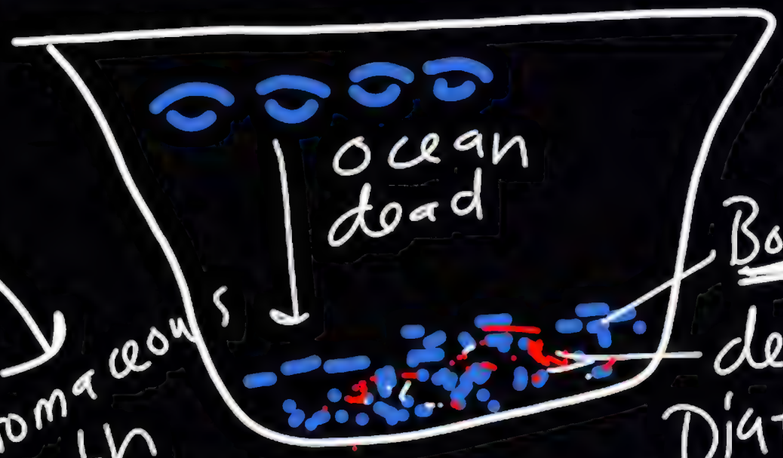
(b) Microscopic, Flagella Absent

(move with water current

– Planktonic movement

(Passive movement

From



diatomaceous Earth ← Silica (Indestructible

(c) Pigment — Chl a present

III nutrition → Oxygenic Photosynthesis

IV Special points

(a) Diatom → Silica → Indestructible → Gritty (खुरदरा)

Use in polishing

Use in syrup making

Use in Filteration

(b) Chief producer in oceans (mainly photosynthesis)

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2.2.1 Chrysophytes

This group includes diatoms and golden algae (desmids). They are found in fresh water as well as in marine environments. They are microscopic and float passively in water currents (plankton). Most of them are photosynthetic. In diatoms the cell walls form two thin overlapping shells, which fit together as in a soap box. The walls are embedded with silica and thus the walls are indestructible. Thus, diatoms have left behind large amount of cell wall deposits in their habitat; this accumulation over billions of years is referred to as 'diatomaceous earth'. Being gritty this soil is used in polishing, filtration of oils and syrups. Diatoms are the chief 'producers' in the oceans.

Dinoflagellates

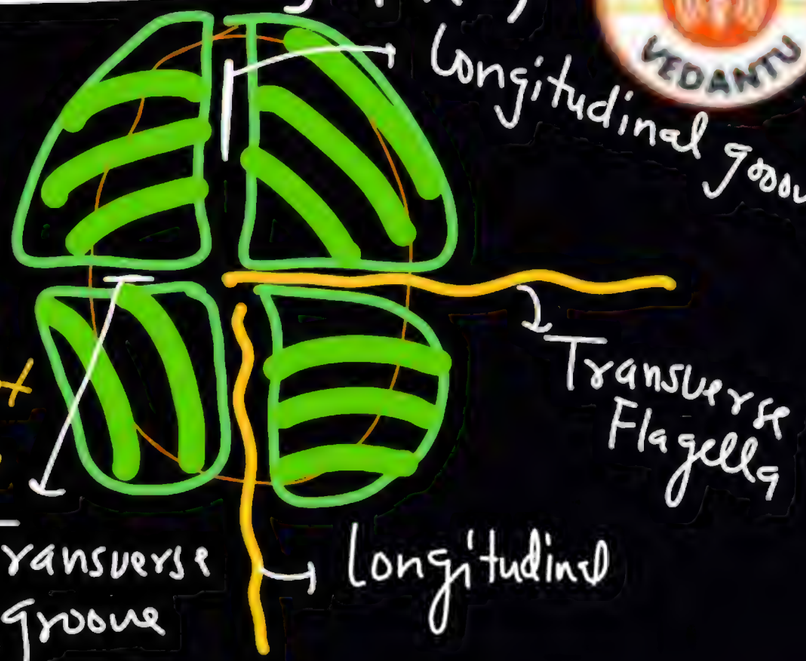
Dino = 2
Flagella = → 9 + (2)

Habitat – Marine (maine)

Structure :- [Cell wall present – Stiff cellulose plate

[Flagella → two – transverse Flagella, Longitudinal Flagella) Different Direction

[Pigment – chla (green) – main pigment
Blue, Red, Brown, Yellow – other pigments also present
(Ex – Red pigment – Phycoerythrin → Red Dinoflagellate – (Gonyalaux)

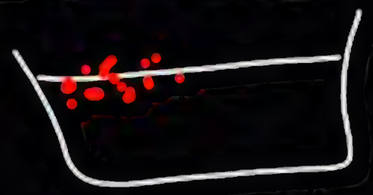


III Nutrition - Oxygenic photosynthesis
(Chla present)

IV Special points →

(a) Flagella present - Active movement

(b) Red dinoflagellate - Red colour → Ex Gonyaulax



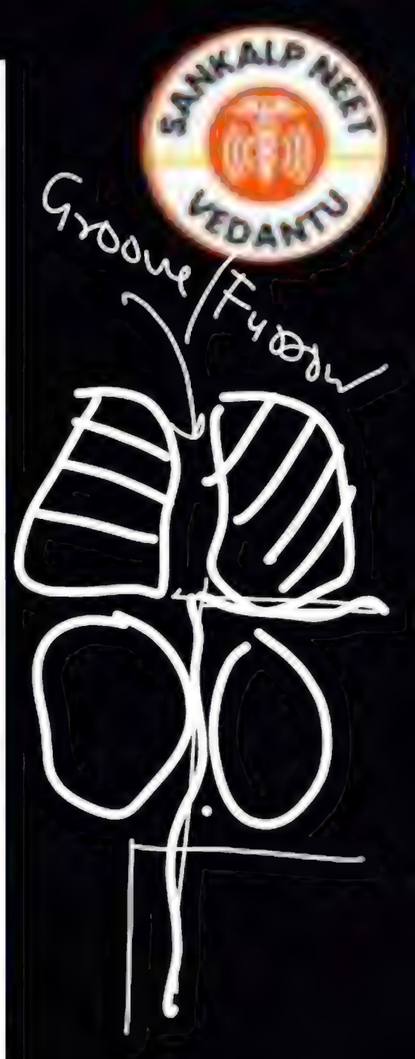
↳ Divide very Fast in ocean
(ocean Appear Red → Red tide)

(c) When Dinoflagellate Excessive Growth → produce toxins
harmful For
Marine life like Fish

2.2.2 Dinoflagellates

.Chl a

These organisms are mostly marine and photosynthetic. They appear yellow, green, brown, blue or red depending on the main pigments present in their cells. The cell wall has stiff cellulose plates on the outer surface. Most of them have two flagella, one lies longitudinally and the other transversely in a furrow between the wall plates. Very often, red dinoflagellates (Example: *Gonyaulax*) undergo such rapid multiplication that they make the sea appear red (red tides). Toxins released by such large numbers may even kill other marine animals such as fishes.



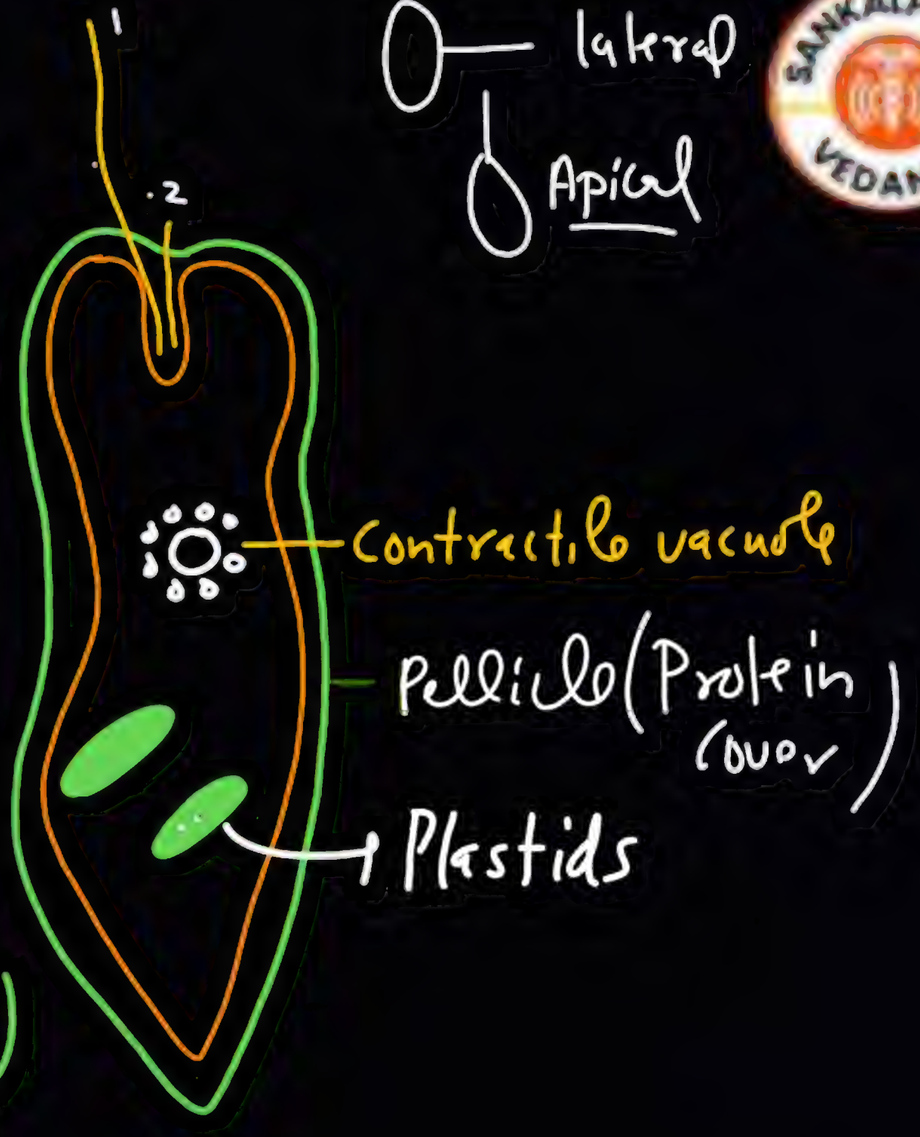
Euglenoids

Habitat → Fresh water → Stagnant (Pond water)

Structure → ① Cell wall Absent → (Contractile vacuole)
– Protein cover is present – Pellicle
(make them Flexible)

② Flagella → two, Unequal (one large)
Apical Flagella

③ Pigment – Plastids present → like higher Plant → (Chl a & Chl b present)



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III Nutrition → When sunlight present
(Autotrophic → oxygenic) — Autotrophic

— In Absence of light, Predator on smaller organism — Heterotrophic

Mixotrophic → Connecting link B/w Plant & Animal

Note — Euglena is an Example of Euglenoids

— Contractile vacuole present

2.2.3 Euglenoids

Majority of them are fresh water organisms found in stagnant water. Instead of a cell wall, they have a protein rich layer called pellicle which makes their body flexible. They have two flagella, a short and a long one. Though they are photosynthetic in the presence of sunlight, when deprived of sunlight they behave like heterotrophs by predating on other smaller organisms. Interestingly, the pigments of euglenoids are identical to those present in higher plants. Example: *Euglena* (Figure 2.4b).

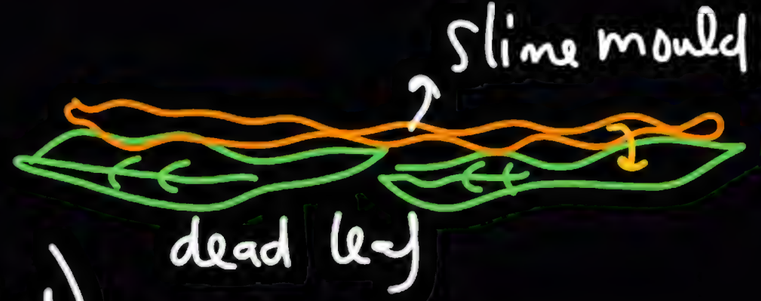
comparison

	Chrysophytes	Dinoflagellates	Euglenoids
Habitat			
Flagella			
Cell wall			
Pigment			
nutrition			
Special point			

Slime moulds

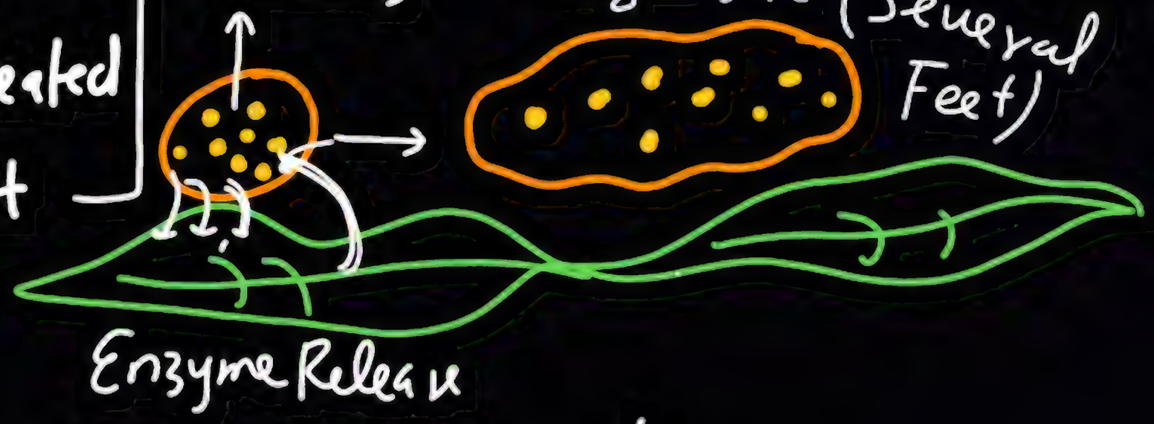
Habitat → Grow or Feed on Decaying twigs or leaf

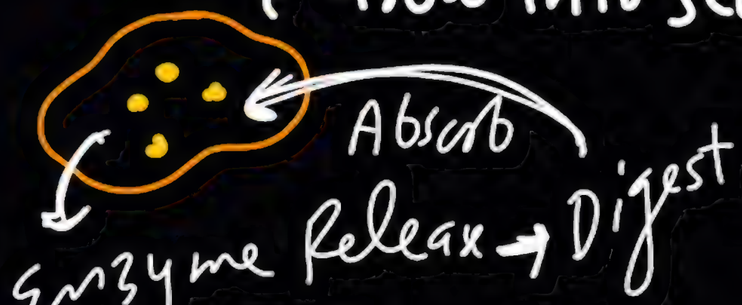
(Enzyme Release → Dead organism (Digest → Absorb Food)



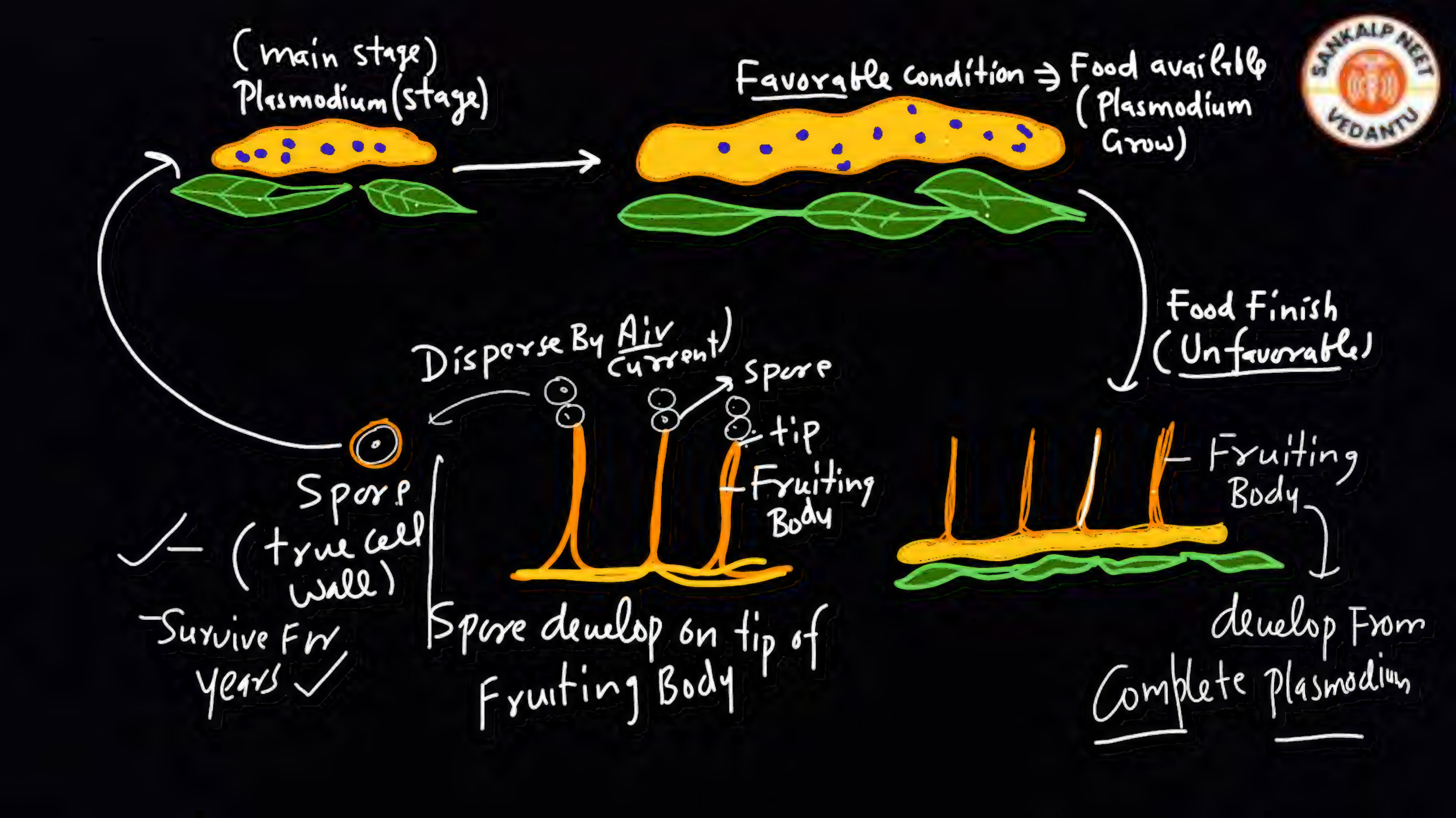
Structure – Main stage is plasmodium

(Without cell wall, Multinucleated & Grow into Several Feet)





nutrition → Saprophytic


(main stage)
Plasmodium (stage)
Favorable condition ⇒ Food available (Plasmodium Grow)
Food Finish (Unfavorable)
Disperse By Air Current
Spore
tip
Fruiting Body
Spore
(true cell wall)
Survive For years
Spore develop on tip of Fruiting Body
Fruiting Body
develop From Complete Plasmodium

2.2.4 Slime Moulds

Slime moulds are saprophytic protists. The body moves along decaying twigs and leaves engulfing organic material. Under suitable conditions, they form an aggregation called plasmodium which may grow and spread over several feet. During unfavourable conditions, the plasmodium differentiates and forms fruiting bodies bearing spores at their tips. The spores possess true walls. They are extremely resistant and survive for many years, even under adverse conditions. The spores are dispersed by air currents.

Protozoans

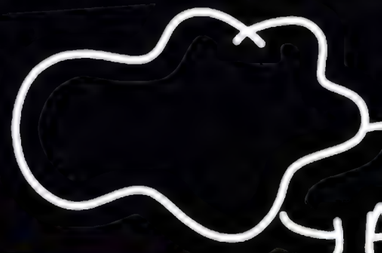
- Close Relatives of Animals → Reason - ① nutrition - only Heterotrophic ✓ (Predator, Parasite, Holozoic)

② Cell wall Absent

On the Basis of locomotory Structure → 4 type of Protozoans

(a) Amoeboid → Amoeba, Entamoeba
(b) Flagellates → Trypanosoma
(c) Cilliates → Parmoecium
(d) Sporozoans → Plasmodium (genus)

I Amoeboid – Freshwater, Marine, Moist soil



Pseudopodia → with this help → Prey capture

↳ Amoeboid Movement

✓ – Amoeba → Fresh water → Food vacuole, contractile vacuole

– Entamoeba → Parasitic → Cause Amoebic dysentry)

– Marine Form → Silica present – outer surface

→ Free living

II Flagellater → Free living + Parasitic

Flagella

Trypanosoma (Parasitic) → Cause Sleeping Sickness Disease

III Ciliates → Cilia on Entire Surface – Ex – Paramoecium

→ cilia →
(a) help in Active movement of cell ✓
(b) Move Food ✓

opening / Cavity on Surface – Mouth → gullet

→ Cilia → coordinated movement
Water with Food move to gullet
↳ steered

IV Sporozoans – no locomotory structure ✓✓
– Spore like infectious stage ✓

Ex – Plasmodium → Cause Malaria

2.2.5 Protozoans

All protozoans are heterotrophs and live as predators or parasites. They are believed to be primitive relatives of animals. There are four major groups of protozoans.

Amoeboid protozoans: These organisms live in fresh water, sea water or moist soil. They move and capture

their prey by putting out pseudopodia (false feet) as in *Amoeba*. Marine forms have silica shells on their surface. Some of them such as *Entamoeba* are parasites.

Flagellated protozoans: The members of this group are either free-living or parasitic. They have flagella. The parasitic forms cause diaseases such as sleeping sickness. Example: *Trypanosoma*.

Ciliated protozoans: These are aquatic, actively moving organisms because of the presence of thousands of cilia. They have a cavity (gullet) that opens to the outside of the cell surface. The coordinated movement of rows of cilia causes the water laden with food to be steered into the gullet. Example: *Paramoecium* (Figure 2.4d).

Sporozoans: This includes diverse organisms that have an infectious spore-like stage in their life cycle. The most notorious is *Plasmodium* (malarial parasite) which causes malaria, a disease which has a staggering effect on human population.

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Biological Classification

lecture - 05

Botany

TARUN SIR

Today's Goal

Fungi

→ → Basic introduction (Habitat, structure, nutrition, Reproduction)

→ → Classification of Fungi

- Phycomycetes → Albugo, Rhizopus, Mucor
- Ascomycetes - Yeast (Saccharomyces), Penicillium, Aspergillus, Claviceps, Morels, truffles (Edible Fungi)
- Basidiomycetes - Neurospora → Agaricus, Ustilago, Puccinia, toadstool
- Deuteromycetes → Colletotrichum, Alternaria, Trichoderma

Fungi

Basic Feature :- (a) Unique Kingdom of Heterotrophic organism

(b) Diversity in Habitat & structure (Morphology)

Example :- (a) Yeast – Bread & Beer

(b) Mustard leaf – white spot

(c) Sugarcane → Red Rot visible

(d) Antibiotic from Fungi – Penicillium

(e) On Bread – Bread mould, Fruits – Rot By Fungi

(f) Agaricus – Mushroom – Edible

(Around us large number of Fungi)

Agaricus

Rust

Smut

Mustard Leaf

Bread Mould

2.3 KINGDOM FUNGI

The fungi constitute a unique kingdom of heterotrophic organisms. They show a great diversity in morphology and habitat. You must have seen fungi on a moist bread and rotten fruits. The common mushroom you eat and toadstools are also fungi. White spots seen on mustard leaves are due to a parasitic fungus. Some unicellular fungi, e.g., yeast are used to make bread and beer. Other fungi cause diseases in plants and animals; wheat rust-causing *Puccinia* is an important example. Some are the source of antibiotics, e.g., *Penicillium*. Fungi are cosmopolitan and occur in air, water, soil and on animals and plants. They prefer to grow in warm and humid places. Have you ever wondered why we keep food in the refrigerator ? Yes, it is to prevent food from going bad due to bacterial or fungal infections.

Habitat → It is cosmopolitan (Found Everywhere → Air, Water, Soil & on Animal & plant)

- Require → warm & Humid (spore germinate)

So, we keep Food in Refrigerator → temp. less than 10°C (Fungi not Grow)

Structure – Fungi is Multicellular (Except – Yeast – unicellular Fungi) ✓

– Detail of structure → two topic study

(a) Cell detail (individual) → ① cell wall → present made up of mainly Chitin & some carbohydrate
② Storage – Glycogen ✓
③ Pigment present – can have colour (But no chlorophyll)
(Mitochondria can present, not plastids)

(b) External structure

(b) External structure (note- Same Mycelium not have Both type of Hyphae)

- main Body of Fungi is **Mycelium**
- Mycelium is made up of hyphae

hyphae (thread)

network of hyphae → [Mycelium]

Fungi (main Body)
(n x hyphae = Mycelium)

→ **hyphae** → long, Slender, thread like
Multicellular, Filamentous

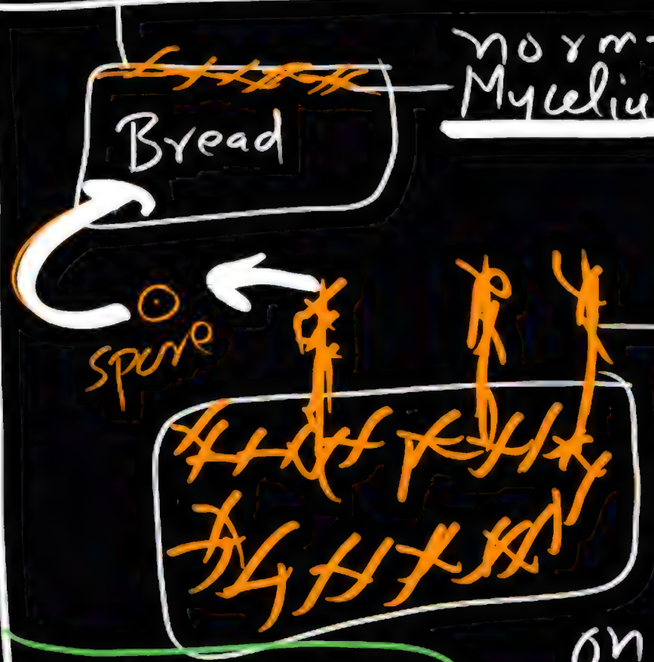
Two type of hyphae

(a) **Aseptate**

↳ tube like, Multinucleated (Coenocytic)
- Septa Absent

(b) Septate → septa present

Septa → Seperate two nucleus



normal **Mycelium** - Horizontal Growth

Fruiting Body (Aerial Mycelium) on which spore develop

note - yeast non - Filamentous

With the exception of yeasts which are unicellular, fungi are filamentous. Their bodies consist of long, slender thread-like structures called hyphae. The network of hyphae is known as mycelium. Some hyphae are continuous tubes filled with multinucleated cytoplasm – these are called coenocytic hyphae. Others have septae or cross walls in their hyphae. The cell walls of fungi are composed of chitin and polysaccharides.

Nutrition → Fungi

nutrition heterotrophic

(a) Saprophytic → (most common)

Most Fungi decomposer

Fungi release Enzyme → outside cell → Digest complex organic Substance (Cellulose)

Simple Soluble Organic Substance (Ex – Glucose)

Absorb By

(b) Parasitic → Many Fungi is parasite on Plants or Animals

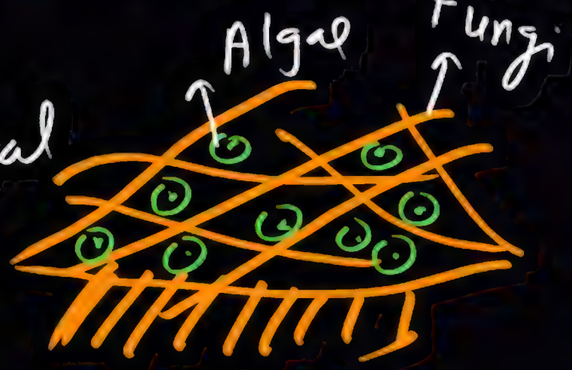
(c) Symbiotic → Both species get Benefit

Lichens → (Symbiotic association)

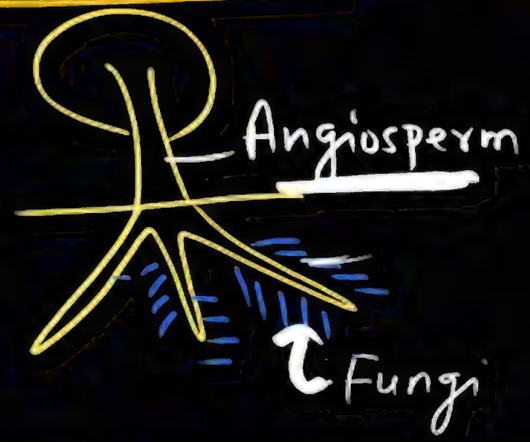
Fungi (Mycobiont) → Absorb water & Mineral & provide it to Algae

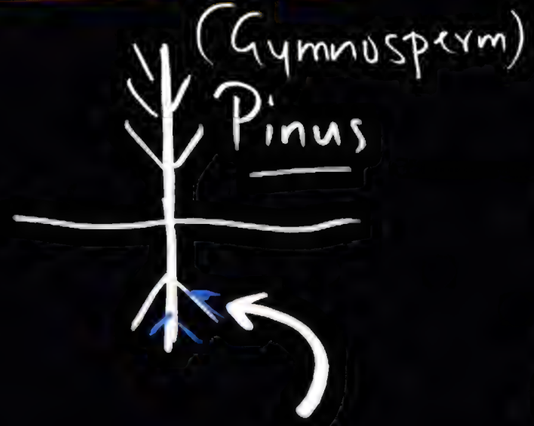
→ Give shelter to Algae

Algae – Photosynthesis (Phycobiont)



Mycorrhiza – Symbiotic association B/w Fungi & Roots of Higher plant





Inc. surface Area to Absorb Water & Mineral

(Angiosperm & Gymnosperm)

Ex-orchid

Ex Pinus

Most fungi are heterotrophic and absorb soluble organic matter from dead substrates and hence are called **saprophytes**. Those that depend on living plants and animals are called **parasites**. They can also live as **symbionts** – in association with algae as **lichens** and with roots of higher plants as **mycorrhiza**.

Reproduction

cell theory

cell theory

cell theory

cell theory

Reproduction in fungi can take place by vegetative means – fragmentation, fission and budding. Asexual reproduction is by spores

called conidia or sporangiospores or zoospores, and sexual reproduction is by oospores, ascospores and basidiospores. The various spores are produced in distinct structures called fruiting bodies. The sexual cycle involves the following three steps:

(i) Fusion of protoplasms between two motile or non-motile gametes called **plasmogamy.**

(ii) Fusion of two nuclei called **karyogamy.**

(iii) Meiosis in zygote resulting in haploid spores.

When a fungus reproduces sexually, two haploid hyphae of compatible mating types come together and fuse. In some fungi the fusion of two haploid cells immediately results in diploid cells (2n). However, in other fungi (ascomycetes and basidiomycetes), an intervening dikaryotic stage (n + n, i.e., two nuclei per cell) occurs; such a condition is called a **dikaryon** and the phase is called **dikaryophase** of fungus. Later, the parental nuclei fuse and the cells become diploid. The fungi form fruiting bodies in which reduction division occurs, leading to formation of haploid spores.

cell theory

The morphology of the mycelium, mode of spore formation and fruiting bodies form the basis for the division of the kingdom into various classes.

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cell theory

cell theory

cell theory

cell theory

cell theory

cell theory

cell theory

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cell theory

cell theory

cell theory

cell theory

cell theory

cell theory

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Biological Classification

lecture - 06

Botany

TARUN SIR

Topics

Fungi

Important Example

Monera → Cyanobacteria → nostoc, Anabena, Oscillatoria,
Mycoplasma → PPLO
Archaebacteria → Methanogen (Methanobacterium), Halophile, thermoacidophile
Symbiotic → Rhizobium, Frankia
Saprophytic → Lactobacillus

Protista → Chrysophytes — Diatom and Desmids
Dinoflagellates - Gonyaulax
Euglenoids — Euglena
Slime mould
Protozoa → Amoeboid [Amoeba, Entamoeba] Flagellates - Trypanosoma
Ciliates [Paramoecium] Sporozoans [Plasmodium]

Fungi

phycomycetes – Albugo, Rhizopus, Mucor

Ascomycetes – Yeast (Saccharomyces) Penicillium, Neurospora Claviceps, Aspergillus, Morels, truffles

Basidiomycetes → Ustilago, Puccinia, toad stool, Agaricus

Deuteromycetes → Colletotrichum, Alternaria, trichoderma

Virus ⟶ SS RNA virus – TMV, HIV, Influenza, Rabies, Rhino, Measles, Mump

DS RNA virus – Hepatitis, Herpes, Chicken pox, Most Bacteriophage

SS DNA virus → ΦX178

viroids ⟶ PSTD Disease

Most fungi are heterotrophic and absorb soluble organic matter from dead substrates and hence are called **saprophytes**. Those that depend on living plants and animals are called **parasites**. They can also live as **symbionts** – in association with algae as **lichens** and with roots of higher plants as **mycorrhiza**.

Reproduction in Fungi

Type of Reproduction — (a) Vegetative (b) Asexual (c) Sexual

I Vegetative ⟶ In Fungi three type

(a) Fragmentation → Each Fragment Grow into new Fungi] Multicellular Fungi

(b) Fission ⟶ Fission

(c) Budding ⟶ Budding

] occur in Unicellular Fungi (Yeast)

What is spore

⊙ – Single cell, haploid

Produce By Mitosis & Meiosis

n Haploid —Mitosis→ ⊙ Spore (n)

(2n) Diploid —Meiosis→ ⊙ Spore (haploid)

Type of spore – Appear in Fungi

I

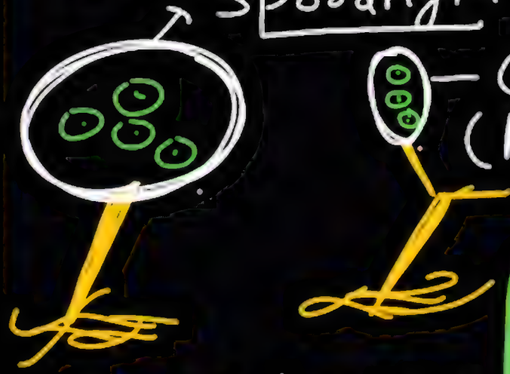
Exogenous

(Without cover)

On Fruiting Body Without cover spore Form

Endogenous

Sporangia



– Spore inside Cover

II

Motile

– Spore with Flagella

– Aquatic Fungi

Knowmas Zoospore (Planospore)

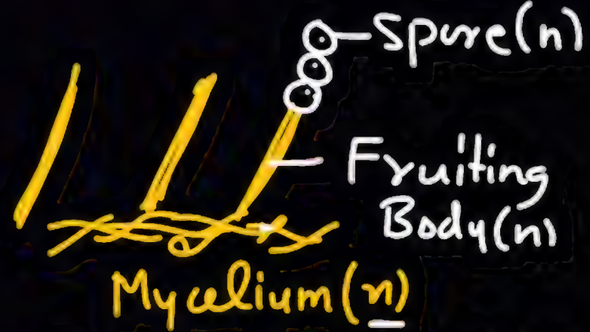
non motile

– Spore without Flagella

– Aplanospore (non-motile spore)

III

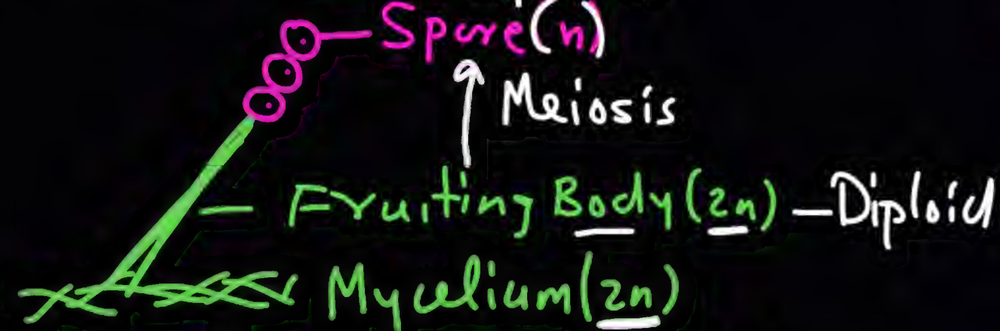
Asexual spore



- Spore develop By Mitosis in Fruiting Body
→ Such spore – Asexual spore (Mito spore)

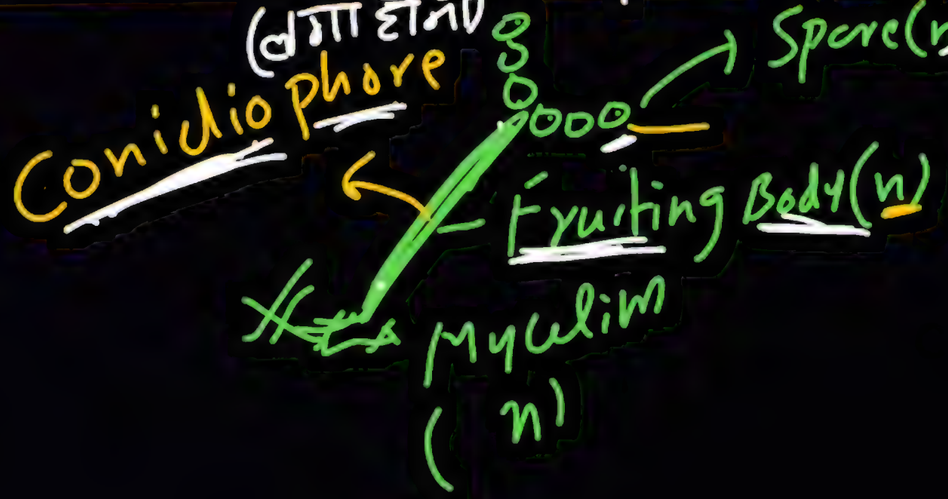
Sexual spore

(haploid)



- Spore develop By Meiosis in Fruiting Body.
- Such spore is Sexual spore

(लंबा होना)



Conidia – [non-motile – Aplanospore, Exogenous, Asexual spore] – Feature

I Asexual Reproduction

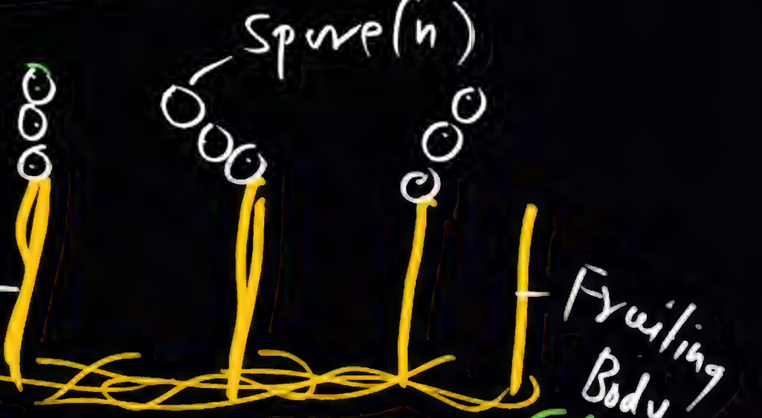
Spore By Mitosis – Asexual spore

– Asexual Reproduction is main mode

→ Spore (n) → develop hyphae (n) → Mycelium From → Fruiting Body → Mitosis → Spore (n)

→ only Mitosis occur

Spore (n) —Mitosis→ hyphae —Mitosis→ (n) Mycelium → (haploid) Fruiting Body



Example – Zoospore, Sporangiospore, Conidia

II Sexual Reproduction – Spore From By Meiosis

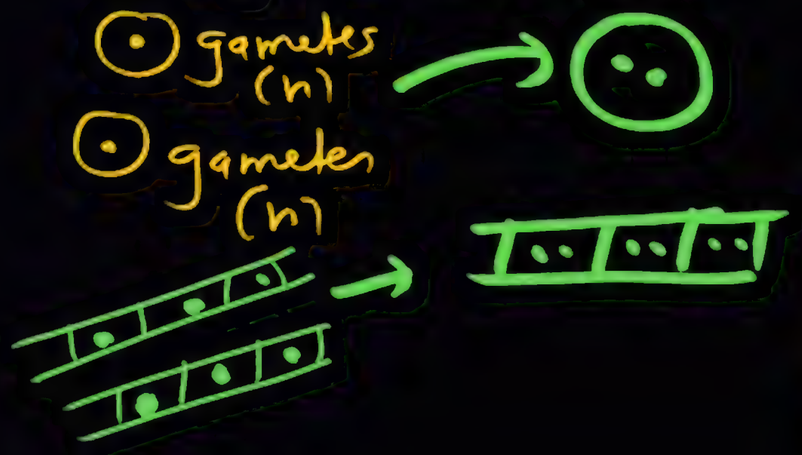
Ex – Oospore, Basidiospore, Ascospore

Reproduction in fungi can take place by vegetative means – fragmentation, fission and budding. Asexual reproduction is by spores called conidia or sporangiospores or zoospores, and sexual reproduction is by oospores, ascospores and basidiospores. The various spores are produced in distinct structures called fruiting bodies. The sexual cycle

sexual Reproduction

- Fungi is Eukaryotic → True Sexual Reproduction occur
→ Fusion of cells (gametes) & Zygote Form
- Fungi → Either gametes Fuse or hyphae get Fuse

⊙(n)	⊙ (n)
Spore	gamete
↓	↓
Divide	Fuse

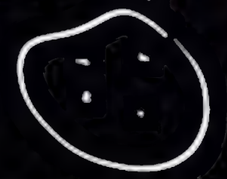


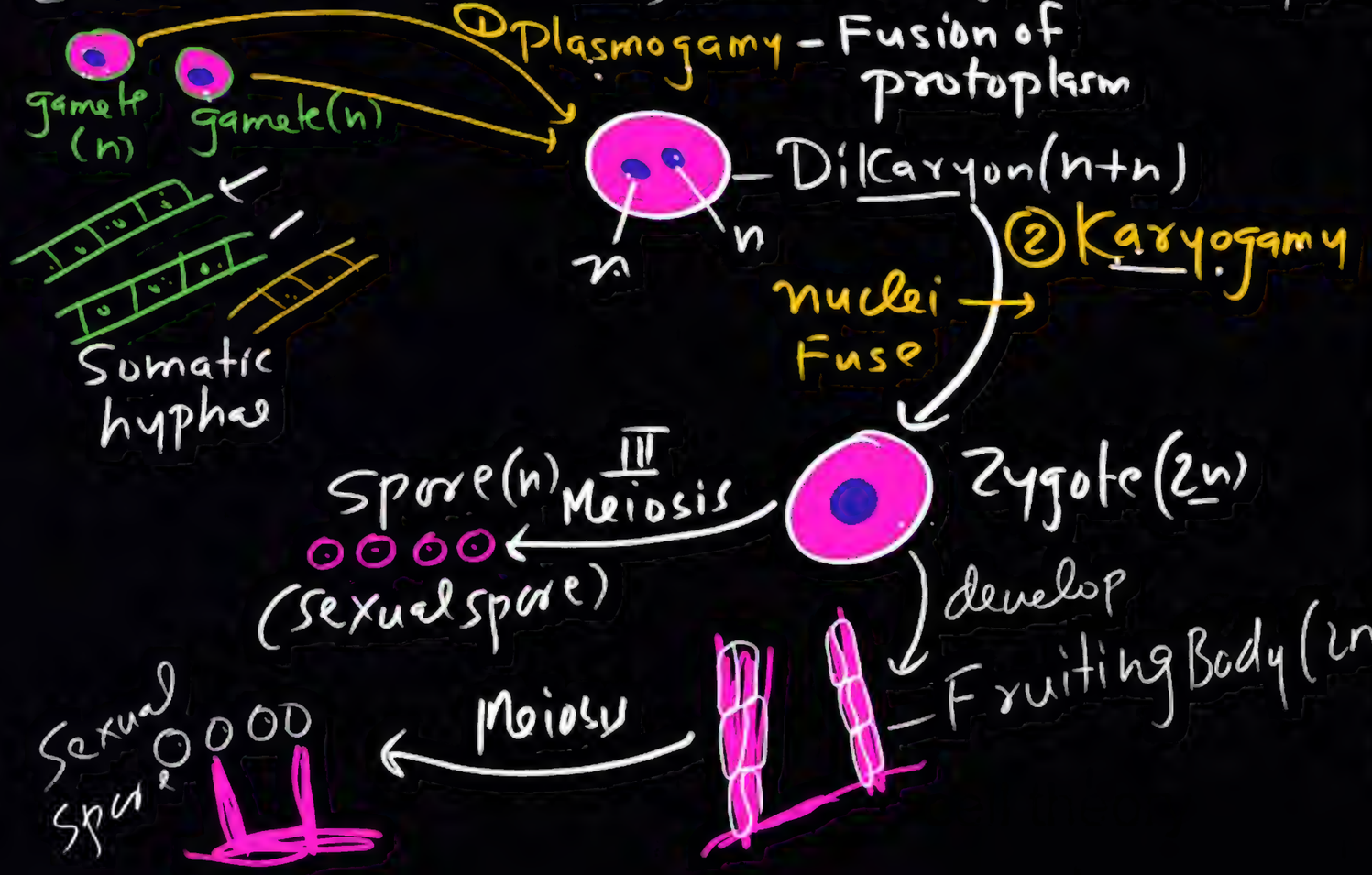
In Fungi, Sexual Reproduction three step

- (a) Plasmogamy
- (b) Karyogamy
- (c) Meiosis

Steps in sexual Reproduction

(a) Plasmogamy — Fusion of protoplasm, Single cell with two nuclei = Dikaryon
(b) Karyogamy → two nuclei Fuse → Zygote
(c) Meiosis → occurs in Zygote or in Diploid Fruiting Body





① Phycomycetes — Dikaryon stage not visible
(Plasmogamy Followed By immediate Karyogamy → Dikaryon not visible)

② Basidiomycetes, Ascomycetes } Dikaryon visible

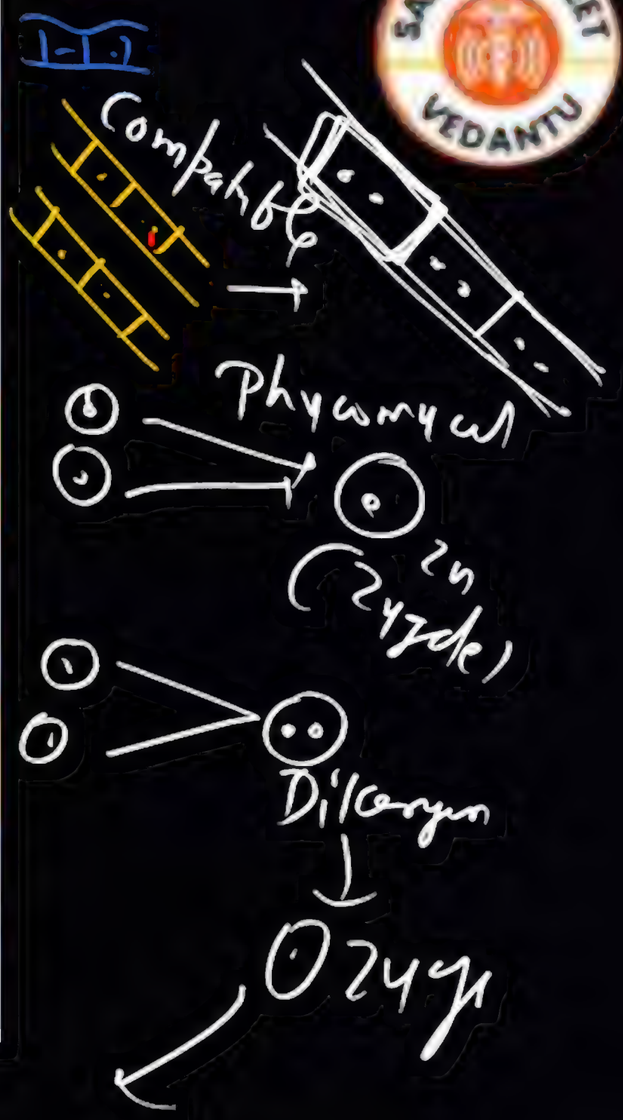
produced in distinct structures called fruiting bodies. The sexual cycle involves the following three steps:

(i) Fusion of protoplasms between two motile or non-motile gametes called **plasmogamy.**

(ii) Fusion of two nuclei called **karyogamy.**

(iii) Meiosis in zygote resulting in haploid spores.

When a fungus reproduces sexually, two haploid hyphae of compatible mating types come together and fuse. In some fungi the fusion of two haploid cells immediately results in diploid cells (2n). However, in other fungi (ascomycetes and basidiomycetes), an intervening dikaryotic stage (n + n, i.e., two nuclei per cell) occurs; such a condition is called a **dikaryon** and the phase is called **dikaryophase** of fungus. Later, the parental nuclei fuse and the cells become diploid. The fungi form fruiting bodies in which reduction division occurs, leading to formation of haploid spores.



Classification of Fungi

Basis :- ① Mycelium Morphology (Aseptate / Septate)

② Fruiting Body (Sexual Fruiting Body) — Fruiting Body develop From Zygote

③ Mode of Spore (Sexual spore)

The morphology of the mycelium, mode of spore formation and fruiting bodies form the basis for the division of the kingdom into various classes.

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Classification of Fungi

Sexual Reproduction → Fruiting Body (Perfect stage)
Asexual Reproduction → Fruiting Body → Imperfect stage

I
Sexual Reproduction Absent
Deuteromycetes
I (Asexual occur)
Fungi imperfecti

Sexual Reproduction present

lower Fungi
(Aseptate hyphae)

II phycomycetes
(Algal Fungi)

Oomycetes
- Some member Aquatic
Ex - Albugo

Zygomycetes
Ex - Mucor
Rhizopus

higher Fungi = Septate hyphae

III Ascomycetes
(Sexual Fruiting Body
cover develop → Asci)
(Sac Fungi)

IV Basidiomycetes
- Club Fungi
- Shelf Fungi

Phycomycetes → Example – Mucor, Rhizopus – Bread mould, Albugo – white spot on Mustard (crucifer)

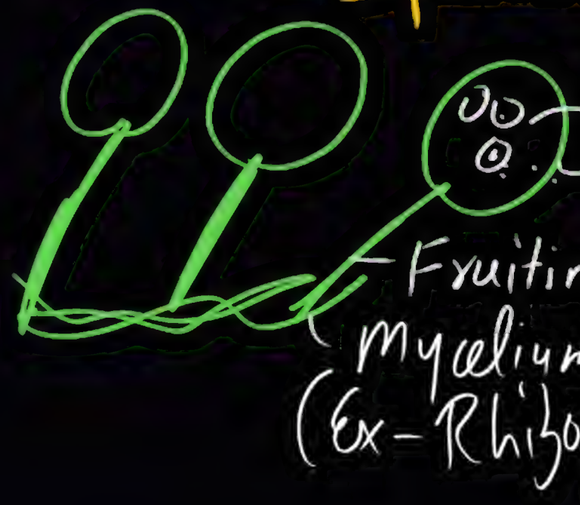
Habitat → Grow on Decaying moist wood
Some member Aquatic, on dead moist material

Structure → Aseptate, Coenocytic

nutrition → mostly saprophytic & Parasitic (Obligate parasite)

Reproduction → (a) Vegetative → Fragmentation

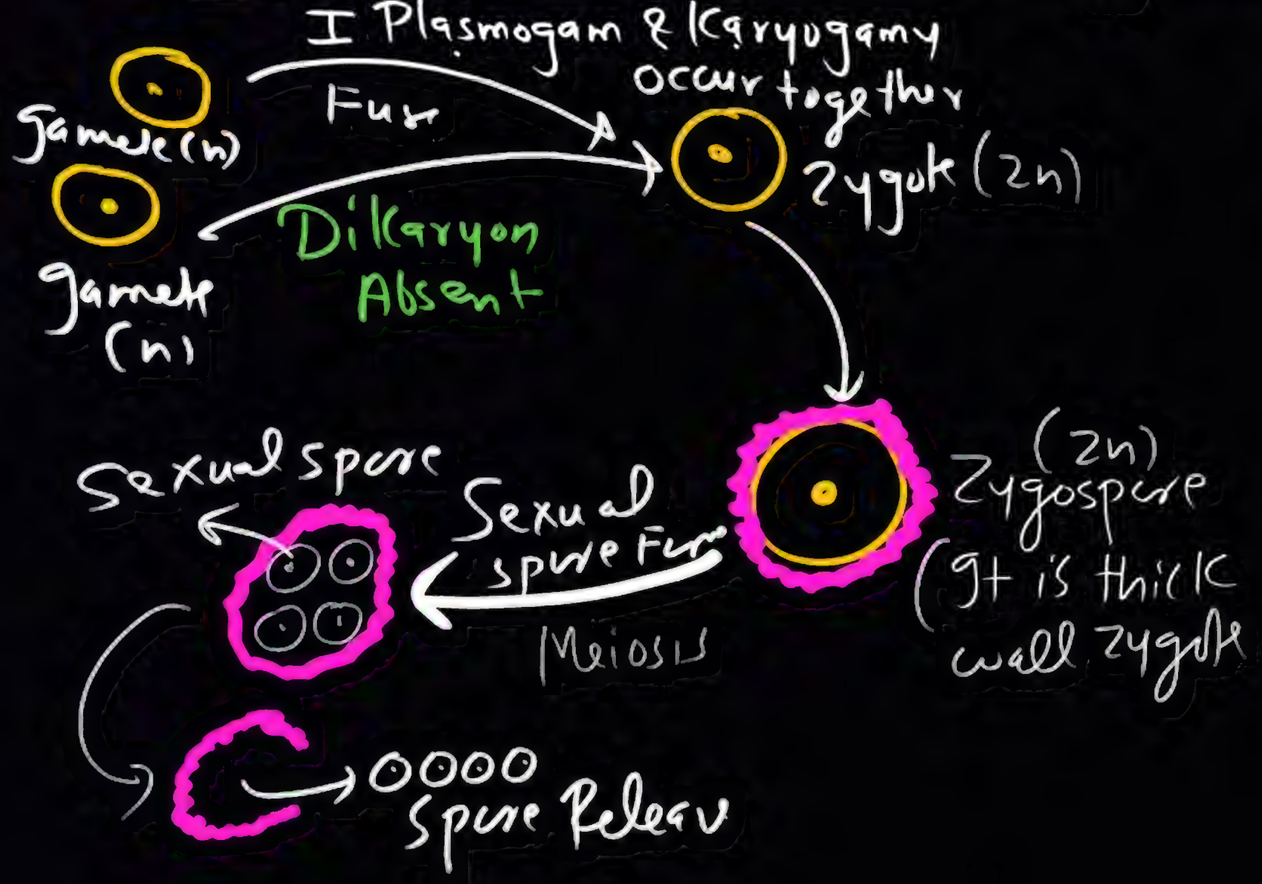
(b) Asexual → haploid mycelium develop haploid Fruiting (n)
Spores – Endogenous (Inside cover = Sporangia) Both motile & non-motile



sexual Reproduction →

– In phycomycetes → Gametes are of Different type

1. ⊙⊙ – Isogamous (Same Morphology)
2. ⊙ ⊙ – Anisogamous
3. ⊙ ◦ – Oogamous (Ex – Albugo)
   (motile)



* Dikaryon Absent
* Zygote is Zygospore
* Sexual spore Form inside Cover – Endogenous

2.3.1 Phycomycetes

Members of phycomycetes are found in aquatic habitats and on decaying wood in moist and damp places or as obligate parasites on plants. The mycelium is aseptate and coenocytic. Asexual reproduction takes place by zoospores (motile) or by aplanospores (non-motile). These spores are endogenously produced in sporangium. A zygospore is formed by fusion of two gametes. These gametes are similar in morphology (isogamous) or dissimilar (anisogamous or oogamous). Some common examples are *Mucor* (Figure 2.5a), *Rhizopus* (the bread mould mentioned earlier) and *Albugo* (the parasitic fungi on mustard).

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Biological Classification

lecture - 07

Botany

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Topics

Fungi -02

Important Example

Monera → Cyanobacteria → nostoc, Anabena, Oscillatoria,
Mycoplasma → PPLO
Archaebacteria → Methanogen (Methanobacterium), Halophile, thermoacidophile
Symbiotic → Rhizobium, Frankia
Saprophytic → Lactobacillus

Protista → Chrysophytes — Diatom and Desmids
Dinoflagellates – Gonyaulax
Euglenoids — Euglena
Slime mould
Protozoa → Amoeboid [Amoeba, Entamoeba] Flagellates - Trypanosoma
Ciliates [Paramoecium] Sporozoans [Plasmodium]

Fungi

phycomycetes – Albugo, Rhizopus, Mucor

Ascomycetes – Yeast (Saccharomyces) Penicillium, Neurospora
Claviceps, Aspergillus, Morels, truffles

Basidiomycetes → Ustilago, Puccinia, toad stool, Agaricus

Deuteromycetes → Colletotrichum, Alternaria, trichoderma

Virus ⟶ SS RNA virus – TMV, HIV, Influenza, Rabies, Rhino, Measles, Mump

DS RNA virus – Hepatitis, Herpes, Chicken pox, Most Bacteriophage

SS DNA virus → ΦX178

viroids ⟶ PSTD Disease

Classification of Fungi

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② Fruiting Body (Sexual Fruiting Body) — Fruiting Body develop From Zygote

③ Mode of Spore (Sexual spore)

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Classification of Fungi

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- Asexual Reproduction → Fruiting Body → Imperfect stage

I — Sexual Reproduction Absent

Deuteromycetes

I (Asexual occur)

Fungi imperfecti

Sexual Reproduction present

lower Fungi

(Aseptate hyphae)

higher Fungi = Septate hyphae

II phycomycetes

(Algal Fungi)

Oomycetes

- Some member Aquatic

Ex – Albugo

Zygomycetes

Ex – Mucor
Rhizopus

III Ascomycetes

(Sexual Fruiting Body

cover develop → Ascus

(Sac Fungi)

IV Basidiomycetes

- Club Fungi
- Shelf Fungi

Phycomycetes

Example - Mucor
Rhizopus - Bread mould
Albugo - white spot on Mustard (crucifer)

Habitat ⟶ Grow on Decaying moist wood
Some member Aquatic, on dead moist material

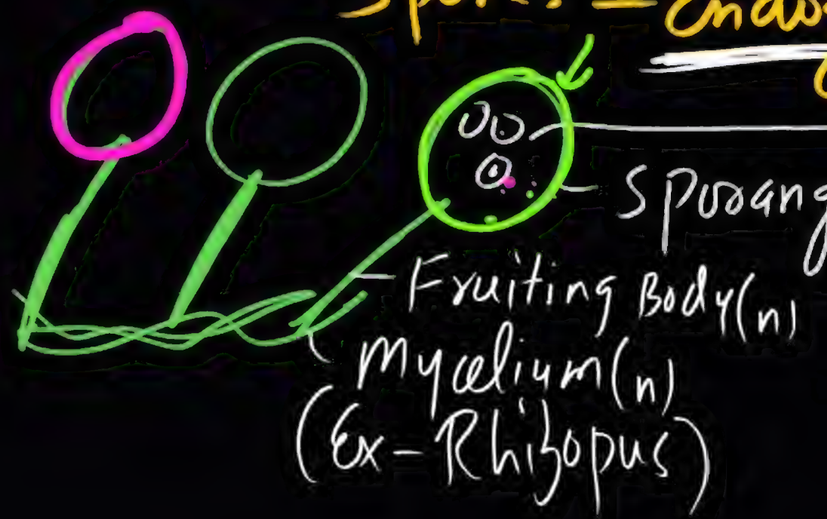
Structure ⟶ Aseptate, Coenocytic

nutrition ⟶ mostly saprophytic & Parasitic (obligate parasite)

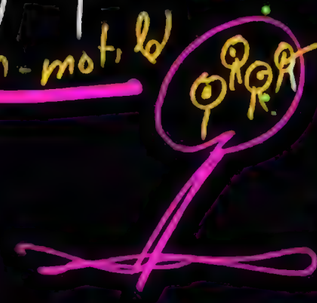
Reproduction ⟶ (a) Vegetative → Fragmentation

(b) Asexual ⟶ haploid mycelium develop haploid Fruiting (n)

Spores - Endogenous (Inside cover = Sporangia)



Both motile & non-motile



sexual Reproduction →

– In phycomycetes → Gametes are of Different type

1. ⊙⊙ – Isogamous (Same Morphology)
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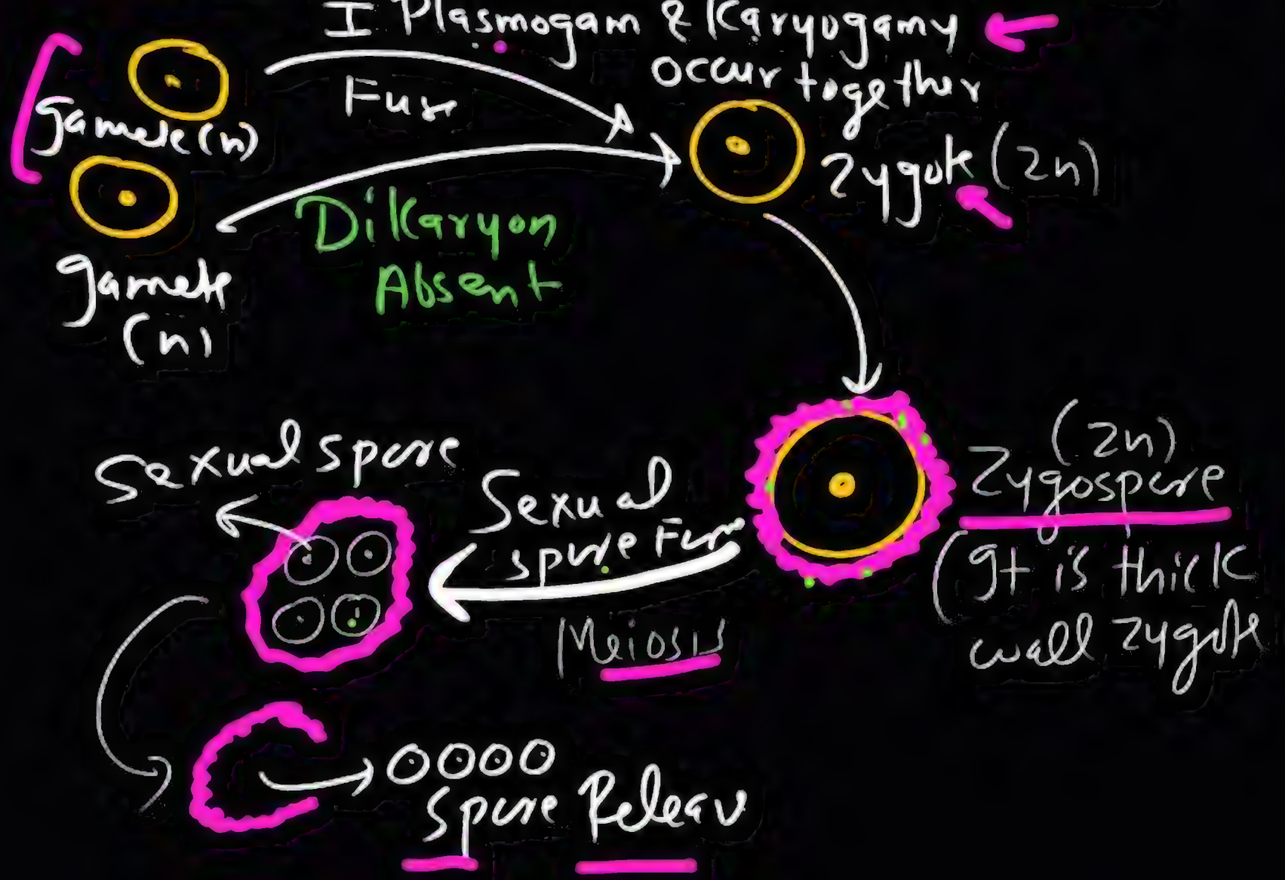
3. ◉ ⊙ – Oogamous (Ex – Albugo)
   (motile)



* Dikaryon Absent ✓
* Zygote is Zygospore ✓
* Sexual spore Form inside Cover – Endogenous
* Asexual spore – Endogenous motile & non-motile

2.3.1 Phycomycetes

Members of phycomycetes are found in aquatic habitats and on decaying wood in moist and damp places or as obligate parasites on plants. The mycelium is aseptate and coenocytic. Asexual reproduction takes place by zoospores (motile) or by aplanospores (non-motile). These spores are endogenously produced in sporangium. A zygospore is formed by fusion of two gametes. These gametes are similar in morphology (isogamous) or dissimilar (anisogamous or oogamous). Some common examples are *Mucor* (Figure 2.5a), *Rhizopus* (the bread mould mentioned earlier) and *Albugo* (the parasitic fungi on mustard).

Ascomycetes

Sac Fungi – Common name

Habitat ⟶ Grow on Dead organism, Grow on Dung (Corporophilus)

Structure ⟶ multicellular → Septate hyphae
Filamentous (Ex. Penicillium)

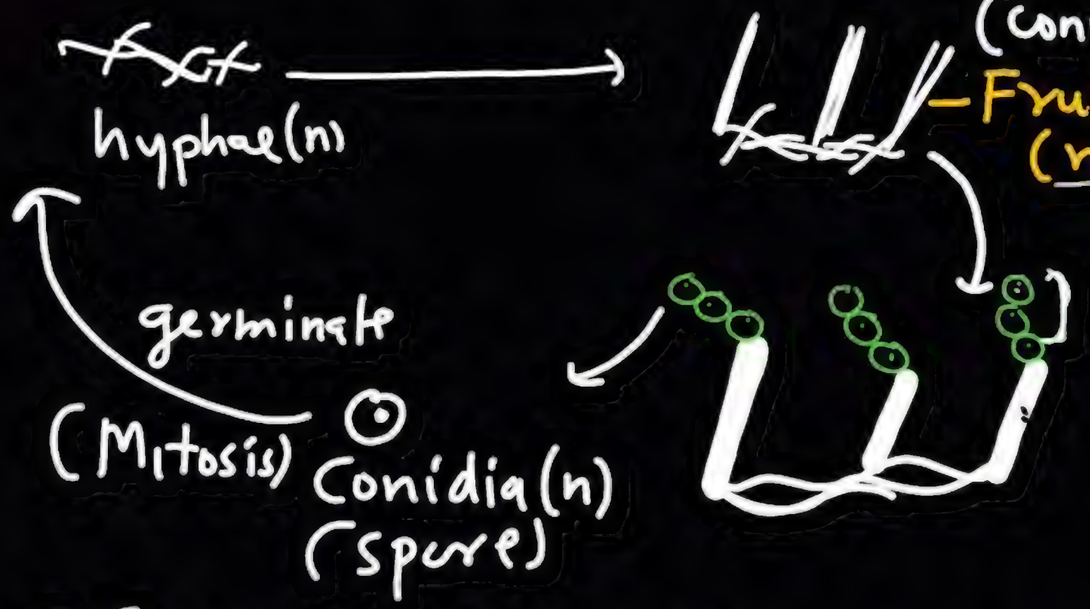
Except – Yeast (Saccharomyces)
non Filamentous
(Unicellular)

nutrition – Mostly saprophytic, parasitic, Symbiotic

Reproduction
- Vegetative ⟶ (a) Fragmentation (b) Fission (c) Budding } – Yeast
- Asexual
- Sexual

Q Aseptate hyphae present in
(a) Clavicips (b) Agaricus (c) Penicillium (d) Mucor
plant Asco Basid (Asco)

Asexual Reproduction → Special Fruiting Body – Conidiophore



* Asexual spore → conidia develop By Mitosis on Fruiting Body (conidiophore)

Conidia → Asexual spore
→ haploid
→ non-motile / Aplanospore
→ Exogenous ✓

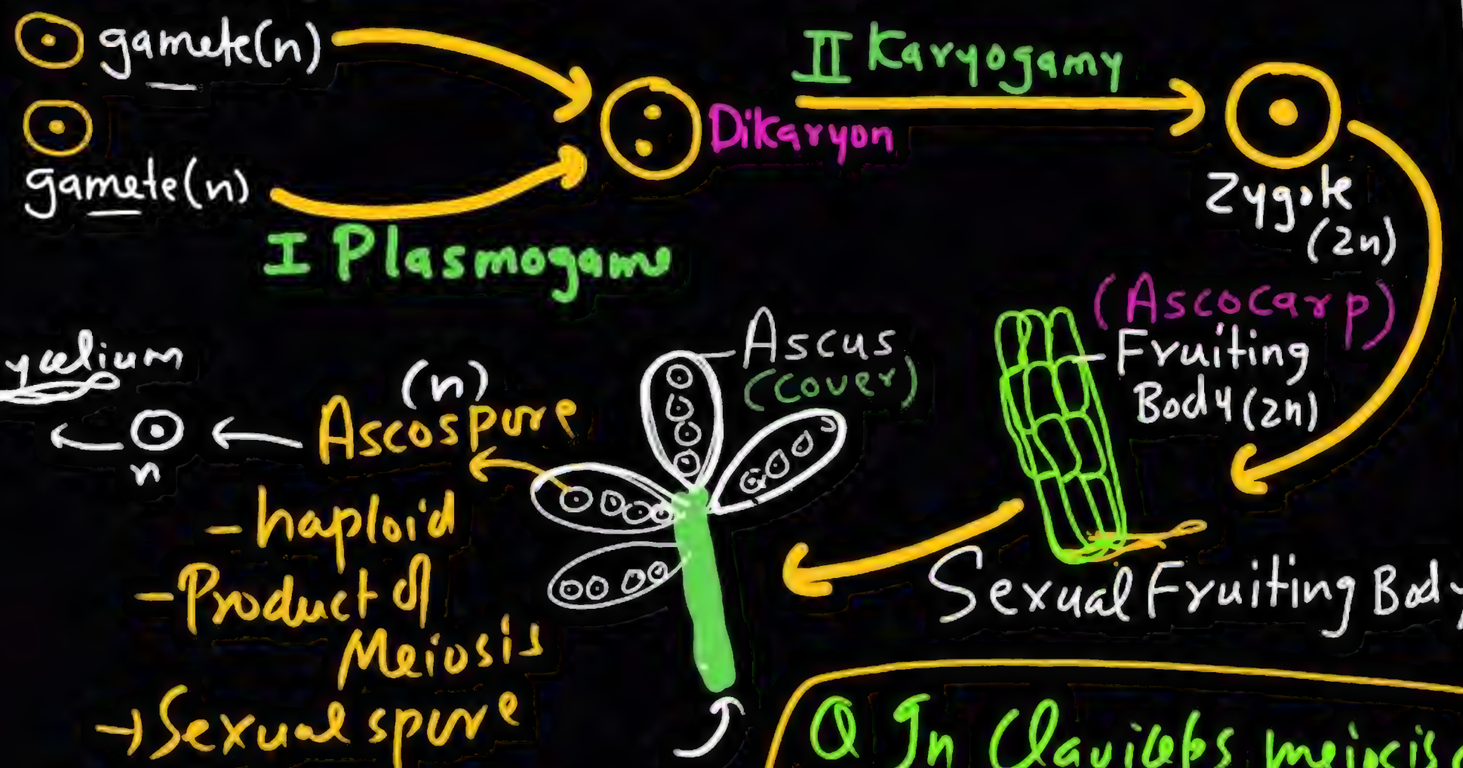
Q Exogenously Produce Asexual spore present in
(a) Mucor (Phy) (b) Aspergillus (Asc)
(c) Rhizopus (Phy) (d) Albugo (Phy)

Q Conidia Present in
(a) Mucor (b) Morels (Asc)
(c) Albugo (d) all ✗

sexual Reproduction

→ haploid Gameles Fuse Dikaryon Form → which give Zygote → Zygote Form Fruiting Body (2n) (2n)

→ On Fruiting Body – Spores Form



* Special Fruiting Body develop From Zygote
* named as Ascocarp
* Ascocarp → Fruiting Body
  ↓
  on which Ascus develop
  ↓
  Inside Ascus meiosis occur → Spore (Ascospore) (Endogenous

Q In Clavicips meiosis occur, in
(a) Ascocarp (b) Ascus
(c) Zygote (d) conidiphore

Example — ① Yeast ⟶ Saccharomyces cerevisiae (Brewer's Yeast, Baker's yeast)
Monascus Purpureus

② Penicillium (Genus) ⟶ Penicillium notatum — produce Antibiotic (Penicillin)

③ Aspergillus ⟶ Produce toxin → Aflatoxin
Aspergillus niger – Citric Acid

④ Clavicaps ⟶ Produce LSD (chemical) → Hallucination occur

(5) Neurospora (Pink mould) → Use in Biochemical & Genetics studies

(6) Morels, truffles } → Edible – Ascocarp edible (delicacies)

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VS
Morels
truffles

Penicillium

2.3.2 Ascomycetes

Commonly known as sac-fungi, the ascomycetes are mostly multicellular, e.g., *Penicillium*, or rarely unicellular, e.g., yeast (*Saccharomyces*). They are saprophytic, decomposers, parasitic or coprophilous (growing on dung). Mycelium is branched and septate. The asexual spores are conidia produced exogenously on the special mycelium called conidiophores. Conidia on germination produce mycelium. Sexual spores are called ascospores which are produced endogenously in sac like asci (singular ascus). These asci are arranged in different types of fruiting bodies called ascocarps. Some examples are *Aspergillus* (Figure 2.5b), *Claviceps* and *Neurospora*. *Neurospora* is used extensively in biochemical and genetic work. Many members like morels and truffles are edible and are considered delicacies.

Basidiomycetes

(Common Mushroom, Puf ball, Bracket Fungi)

Habitat → Grow on dead Organism, on wooden log, tree stumps

Structure → Septate Branch

nutrition – Saprophytic, Parasitic, symbiotic

Reproduction → (a) Vegetative – Fragmentation common

(b) Asexual → **Asexual spore Absent** (no Asexual Fruiting Body)

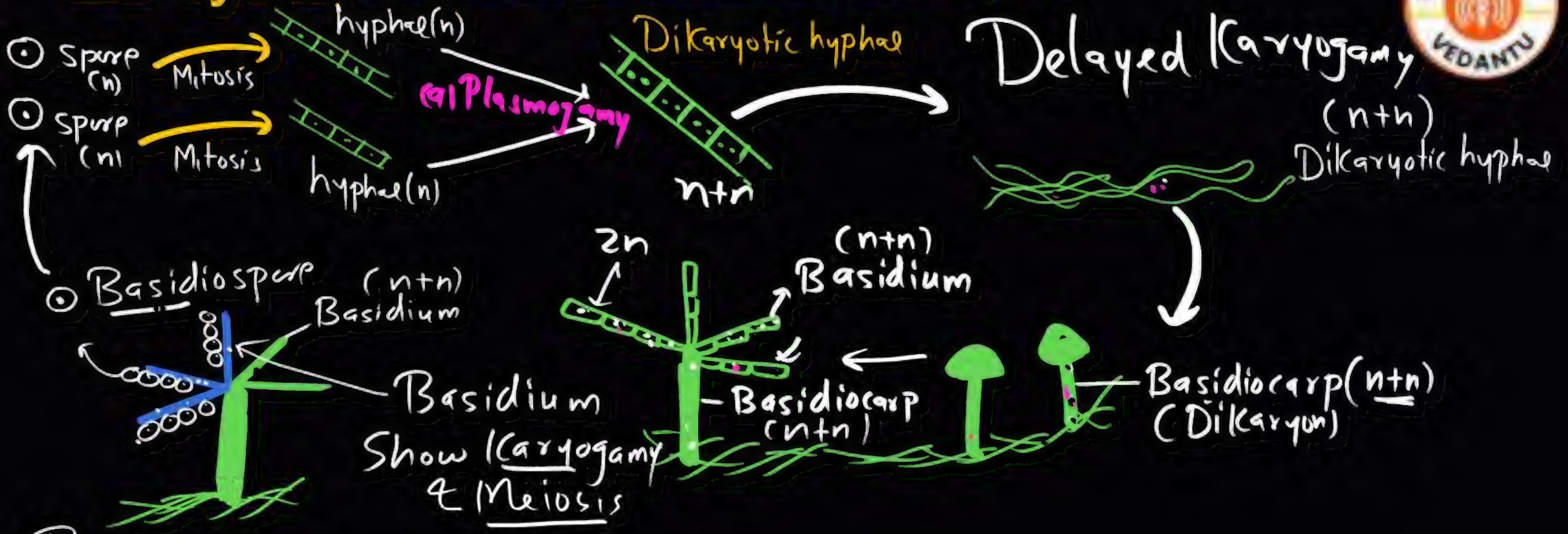
(c) Sexual Reproduction → (Present)

Sex organ Absent → Gametes not Form

Somatic hyphae } hyphae Fuse for sexual Reproduction

Simple hyphae → Dikaryotic hyphae

life cycle sexual Reproduction – Basidiomycetes



Basidiospore → haploid, Sexual spore
→ Product of Meiosis
Exogenous

Example

- Agaricus – Mushroom (Edible – Basidiocarp)
- Ustilago cause Smut in wheat leaf
- Puccinia cause Rust in wheat

2.3.3 Basidiomycetes

Commonly known forms of basidiomycetes are mushrooms, bracket fungi or puffballs. They grow in soil, on logs and tree stumps and in living plant bodies as parasites, e.g. rusts and smuts. The mycelium is branched and septate. The asexual spores are generally not found, but vegetative reproduction by fragmentation is common. The sex organs are absent, but plasmogamy is brought about by fusion of two vegetative or somatic cells of different strains or genotypes. The resultant structure is dikaryotic which ultimately gives rise to basidium. Karyogamy and meiosis take place in the basidium producing four basidiospores. The basidiospores are exogenously produced on the basidium (pl.: basidia). The basidia are arranged in fruiting bodies called basidiocarps. Some common members are *Agaricus* (mushroom) (Figure 2.5c), *Ustilago* (smut) and *Puccinia* (rust fungus).

	Phycomycetes	Ascomycetes	Basidiomycetes	Deuteromycetes
Habitat	Some Aquatic	Some coprophilous	Grow on log	Mineral cycling
Hyphae	Aseptate	Septate	Septate	Septate
Asexual	Endogenous inside Sporangia (Motile or non-motile)	Conidia on condiophore Exogenous non-motile	Absent	Conidia
sexual	Endogenous inside Zygospore Mucor Albugo Rhizopus	inside Ascus on Ascocarp (Sexual Fruiting Body) (Dikaryon)	Sex organ Absent Sexual spore Exogenous (Dikaryon) Delayed Karyogamy	Not Discovered yet

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Rust

Smut

Deuteromycetes (Fungi imperfecti)

Habitat – Grow as decomposer on litter (wast) & Mineral cycling

Structure – Hyphae Septate

nutrition – Saprophytic & parasitic

Reproduction – Fragmentation

Asexual spore – conidia

Sexual Reproduction – not Discovered yet

Perfect stage – Sexual Fruiting Body

Imperfect stage – Asexual Fruiting Body

(Asexual Fruiting Body)

Deuteromycetes – temporary Group – For Fungi – only Asexual stage visible

When Sexual Fruiting Body → tranfer into right Group

(Ascomycetes & Basidiomycetes)

→ It is possible same Fungi → Asexual stage is in Deuteromycetes with some name

& Sexual stage is in Ascomycetes with other name

Example – Alternaria –

→ Colletotrichum – Red Rot of Sugarcane

→ Trichoderma → Biocontrol Agent

(trichoderma polysporum – Cyclosporin A

2.3.4 Deuteromycetes

Commonly known as imperfect fungi because only the asexual or vegetative phases of these fungi are known. When the sexual forms of these fungi were discovered they were moved into classes they rightly belong to. It is also possible that the asexual and vegetative stage have been given one name (and placed under deuteromycetes) and the sexual stage another and placed under another class. Later when the linkages were established, the fungi were correctly identified and moved out of deuteromycetes. Once perfect (sexual) stages of members of dueteromycetes were discovered they were often moved to ascomycetes and basidiomycetes. The deuteromycetes reproduce only by asexual spores known as conidia. The mycelium is septate and branched. Some members are saprophytes or parasites while a large number of them are decomposers of litter and help in mineral cycling. Some examples are *Alternaria*, *Colletotrichum* and *Trichoderma*.

DOPA-01

01 – S-I Ascospore is Sexual spore
S-II Ascus is Diploid

02 – S-I Ascocarp & Basidiocarp sexual Fruiting Body
– S-II Sexual spore is Exogenous in Aspergillus

03 – S-I Conidia present in Alternaria
– S-II Conidia present in Puccinia

04 – S-I Ustilago & Alternaria is parasitic Fungi
S-II Morels & truffles are Edible Fungi

05 – S-I Red Rot of sugarcan Cause By Aspergillus
S-II Neurospora also produce Conidia

(A) Only S-I Correct (B) Only S-II Correct (C) Both S-I & S-II Correct (D) Both wrong

Q6 Mark the correct Match

(a) Puff ball – conidia (b) Ustilago – Smut

(c) Yeast – Filamentous (d) Agaricus – Rust

Q7 Mark the incorrect match

(a) Albugo – Zygospore (b) Aspergillus – Ascospore

(c) Ustilago – Dikaryon (d) Alternaria = Dikaryon

Q8 Mark the correct Match

(a) toad stool – Basidiomycetes (b) Mucor – septate

(c) Morels – Aseptate (d) Aspergillus – Basidiospore

Q9 Mark the incorrect Match

(a) Exogenous Asexual spore – trichoderma (b) Conidia – Claviceps

(c) Exogenous sexual spore – Agaricus (d) Albugo – Rust

Q10 Mark the correct Match

(a) Mineral cycling – Ascomycetes (b) Coprophilus – Phycomycetes

(c) Aseptate – Ascomycetes (d) Aquatic – phycomycetes

11 Which is genetically identical
(a) two ascospore of one Ascus (b) two conidia of one conidiophore
(c) two Basidiospore of one Basidium (d) all

12 Which is not Diploid
(a) Zygote (b) Ascocarp (c) Ascus (d) Basidiospore

13 Which is Meiospore
(a) Ascospore (b) Basidiospore (c) oospore (d) all

14. Motile Asexual spore present in
(a) Phycomycetes (b) Ascomycetes (c) Deuteromycetes (d) Basidiomycetes

15 Not true For Basidiomycetes
(a) Sex organ Absent (b) Perfect Fruiting Body Present
(c) Meiospore present (d) Mitospore Present

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Biological Classification

lecture - 08

Botany

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Topics

Virus

viroids

prions

Important Example

Monera →
- Cyanobacteria → nostoc, Anabena, Oscillatoria,
- Mycoplasma → PPLO
- Archaebacteria → Methanogen (Methanobacterium), Halophile, thermoacidophile
- Symbiotic → Rhizobium, Frankia
- Saprophytic → Lactobacillus

Protista →
- Chrysophytes — Diatom and Desmids
- Dinoflagellates – Gonyaulax
- Euglenoids — Euglena
- Slime mould
- Protozoa → Amoeboid [Amoeba, Entamoeba] Flagellates - Trypanosoma
  Ciliates [Paramoecium] Sporozoans [Plasmodium]

Fungi

phycomycetes – Albugo, Rhizopus, Mucor

Ascomycetes – Yeast (Saccharomyces) Penicillium, Neurospora
Clavicaps, Aspergillus, Morels, truffles

Basidiomycetes → Ustilago, Puccinia, toad stool, Agaricus

Deuteromycetes → Colletotrichum, Alternaria, trichoderma

Virus → SS RNA virus – TMV, HIV, Influenza, Rabies, Rhino, Measles, Mump

DS RNA virus – Hepatitis, Herpes, Chicken pox, Most Bacteriophage

SS DNA virus → Φ X 178

viroids → PSTD Disease

cell theory

	Phycomycetes	Ascomycetes	Basidiomycetes	Deuteromycetes
Habitat	Some Aquatic	Some coprophilous	Grow on log	Mineral cycling
Hyphae	Aseptate	Septate	Septate	Septate
Asexual	Endogenous inside Sporangia (Motile or non-motile)	Conidia on condiophore Exogenous non-motile	Absent	Conidia
sexual	Endogenous inside Zygospore Mucor Albugo Rhizopus	inside Ascus on Ascocarp (Sexual Fruiting Body) (Dikaryon)	Sex organ Absent Sexual spore Exogenous (Dikaryon) Delayed Karyogamy	Not Discovered yet

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DOPA-01

Q1 – S-I Ascospore is Sexual spore ✓
S-II Ascus is Diploid ✓ (c)

Q2 – S-I Ascocarp & Basidiocarp sexual Fruiting Body ✓ (a)
– S-II Sexual spore is Exogenous in Aspergillus (Asco) X

Q3 – S-I Conidia present in Alternaria (Deutero) (a)
– S-II Conidia present in Puccinia X

Q4 – S-I Ustilago & Alternaria is parasitic Fungi ✓
S-II Morels & truffles are Edible Fungi ✓ (c)

Q5 – S-I Red Rot of sugarcan Cause By Aspergillus X
S-II Neurospora also produce Conidia ✓ (b)
(Asco)

(a) Only S-I Correct (b) Only S-II Correct ((c)) Both S-I & S-II Correct (d) Both wrong

Q6 Mark the correct Match

(a) Puff ball – conidia ✗ (b) Ustilago – Smut ✓

(c) Yeast – Filamentous ✗ (d) Agaricus – Rust ✗

Q7 Mark the incorrect match

(a) Albugo – Zygospore (Phyo) ✗ (b) Aspergillus – Ascospore (Asco) ✗

(c) Ustilago – Dikaryon (Bas) ✗ Alternaria = Dikaryon (d)

Q8 Mark the correct Match

(a) toad stool – Basidiomycetes ✓ (b) Mucor – septate (X) (Phy)

(c) Morels – Aseptate ✗ (d) Aspergillus – Basidiospore ✗ (Asco)

(a)

Q9 Mark the incorrect Match

(a) Exogenous Asexual spore – trichoderma ✓ (b) Conidia – Claviceps

(c) Exogenous sexual spore – Agaricus ✓ Albugo – Rust (d)

d

Q10 Mark the correct Match

(a) Mineral cycling – Ascomycetes ✗ (b) Coprophilus – phycomycetes ✗ (Asco)

(c) Aseptate – Ascomycetes ✗ (d) Aquatic – phycomycetes ✓

D

11 Which is genetically identical
(a) two ascospore of one Ascus (b) two conidia of one conidiophore ✓
(c) two Basidiospore of one Basidium (d) all

12 Which is not Diploid
(a) Zygote (b) Ascocarp (c) Ascus (d) Basidiospore
2n 2n 2n n

13 Which is Meiospore (Sexual)
(a) Ascospore (b) Basidiospore (c) oospore (d) all

14. Motile Asexual spore present in
(a) Phycomycetes (b) Ascomycetes (c) Deuteromycetes (d) Basidiomycetes
(a)

15 Not true For Basidiomycetes
(a) Sex organ Absent (b) Perfect Fruiting Body Present
(c) Meiospore present (d) Mitospore Present (Asexual) (d)

Plant Kingdom ⟶ tissue & organ (Root, stem, leaf) ★

- True cell wall
- ★ Storage - Starch & oil
- Cell wall - cellulose
- all plants Autotrophic (Oxygenic)
- Some plants parasite - Cuscuta (अमरबेल)
- Some insectivorus → Insect Eat for N_2 → Bladder wort, Venus Fly trap

Animal kingdom → Cell wall Absent

★ Storage - Glycogen

★ → tissue, organ & organ system (Digestive system)

Not get place in Any Kingdom

Virus
Viroids
Prions
– not get place in Kingdom ⟶ Because they are not cell

Lichens
Mycorrhizae
⟶ They are not organism
they are association B/w two species

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Virus

Important Feature:- ① meaning - Poisonous Fluid

② Virus is not cell ⟶ Acellular or Non cellular

③ Crystalline structure

④ chemically - Nucleo protein (nucleic Acid + protein)

⑤ Either DNA or RNA present (never both together)

⑥ Obligate Parasite - Complete depend on host ✓

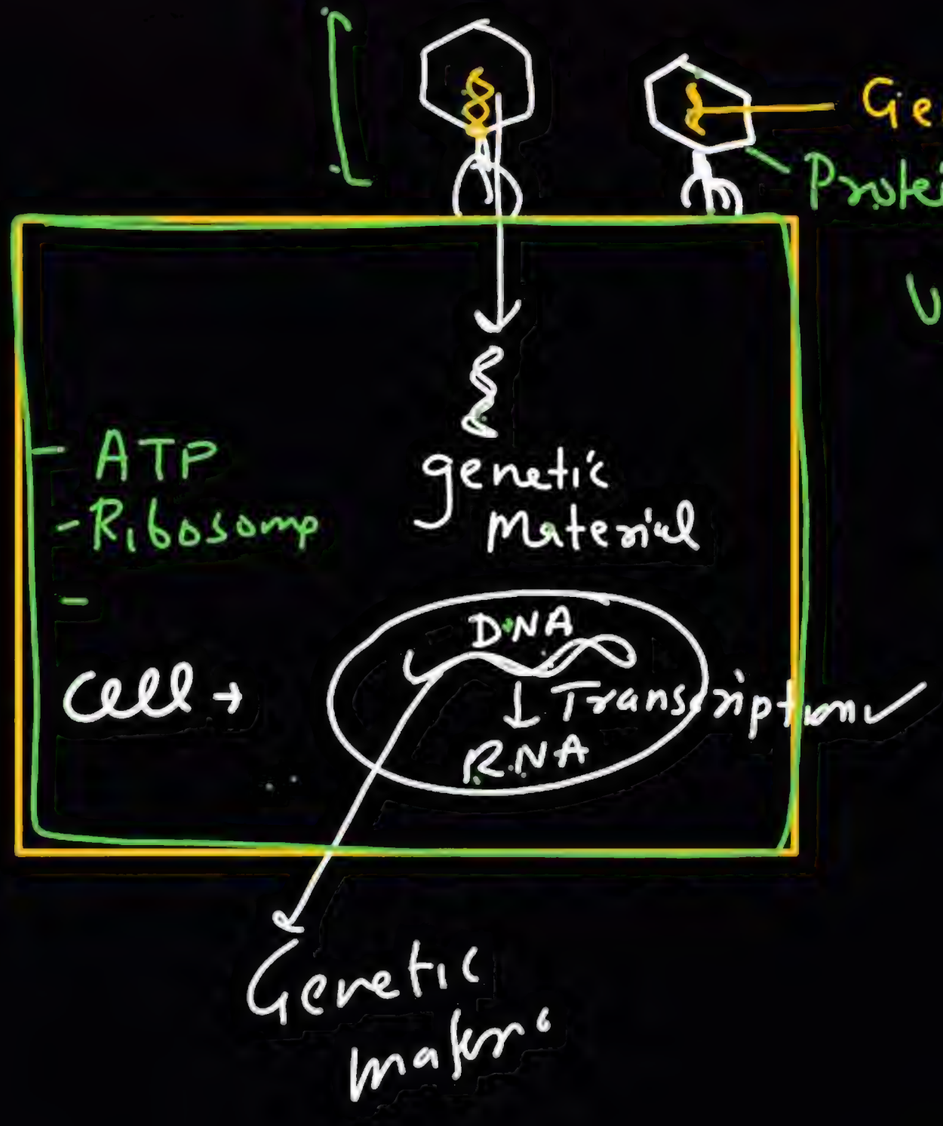
⑦ Intracellular Parasite (Active only inside cell)

⑧ Infectious is - Genetic material ✓

(a) Virus take control of Entire machinery of cell -

Virus not have
- Cytoplasm
- Organelles
- not possible to make own ATP
- Ribosome Absent

- only - Genetic material present

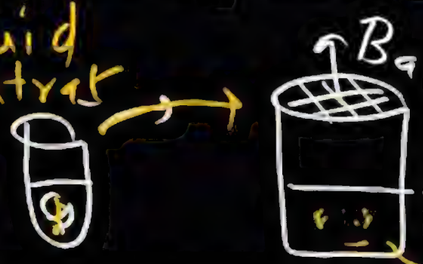


Virus → nucleic acid + protein = nucleoprotein

Discovery of virus – First virus → TMV – Tobacco mosaic virus

① 1892 ① Ivanwosky → leaf with infection of TMV → Fluid Extract → Pass through Bacterial Proof Filter (Stop Bacteria)

Fluid Extract →



→ Something smaller than Bacteria

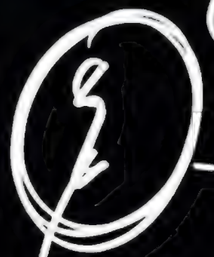
② Beijerinek – 1898 — From infected leaf (mosaic disease) Fluid Extract

Observe that → Fluid is living → can cause 'Fresh infection'

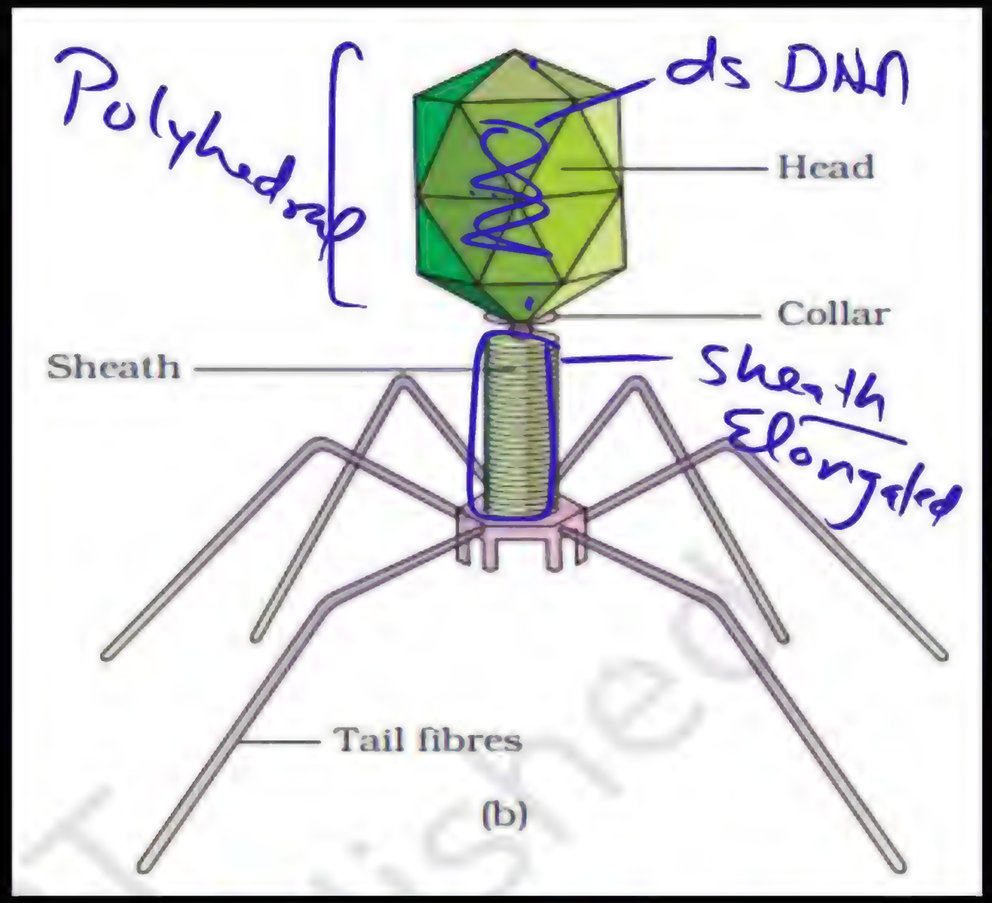
→ 'Contagum vivum Fluidum' or 'infection causing living Fluid'

Stanley – 1935 – First time Stanley – Crystallise virus'

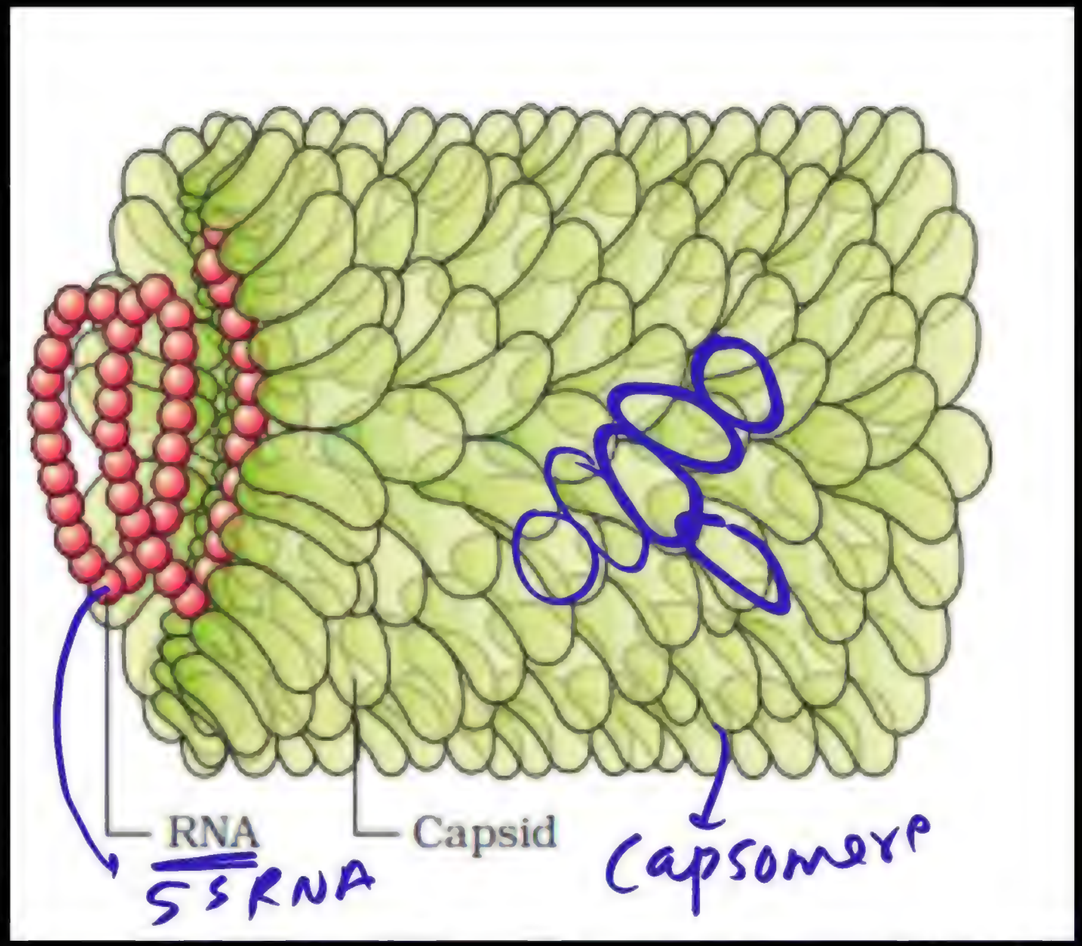
Crystal is mainly made up of protein



– protein cover
↳ Genetic material



Bacteriophage



Cylindrical/helical

Capsid = n × Capsomere

Structure of virus – virus is chemically – nucleo protein

↳ two part (a) Outer capsid/cover (b) Genetic material

(A) Capsid

Cover = protein

→ Capsid → many unit Repeat many time – Capsomere

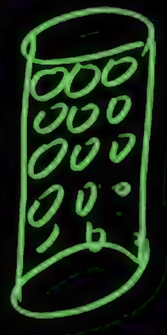
n X Capsomere = Capsid

Role of capside ⊕ Protection of Genetic material

② help in infection

I Symmetry or shape of capsid

(a) Polyhedral or spherical } visible in Bacteriophage

(b) Elongated/cylindrical or Helical  } visible in TMV

(c) Complex – Both polyhedral & Helical

II Genetic material

In all living cell → Either prokaryote or Eukaryotes
Genetic material is Double strand DNA

– But virus ⟶ DNA or RNA (Any one can be Genetic material)

Genetic material (Virus)

SS DNA virus
(Single strand DNA virus)
↓
Ex – Φ X174 virus

ds DNA virus
↓
– Hepatitis virus
– Herpes virus
– Chicken pox
Most Bacteriophage

ds RNA virus
(Rare

SS RNA virus
H – HIV
I – influenza
V – TMV
M – Measles
M – Mumps
R – Rabies, Rhino virus (common cold)
Covid virus ✓

note – Most Bacteriophage – ds DNA virus
– Plant virus → SS RNA virus (Ex – TMV)
– Animal virus → ds DNA, SS RNA, ds RNA virus

} NCERT

2.6 Viruses, Viroids, Prions and Lichens

In the five kingdom classification of Whittaker there is no mention of lichens and some acellular organisms like viruses, viroids and prions. These are briefly introduced here.

All of us who have suffered the ill effects of common cold or 'flu' know what effects viruses can have on us, even if we do not associate it with our condition. Viruses did not find a place in classification since they are not considered truly 'living', if we understand living as those organisms that have a cell structure. The viruses are non-cellular organisms that are characterised by having an inert crystalline structure outside the living cell.

Once they infect a cell they take over the machinery of the host cell to replicate themselves, killing the host. Would you call viruses living or non-living?

The name virus that means venom or poisonous fluid was given by Dmitri Ivanowsky (1892) recognised certain microbes as causal organism of the mosaic disease of tobacco (Figure 2.6a). These were found to be smaller than bacteria because they passed through bacteria-proof filters. M.W. Beijerinek (1898) demonstrated that the extract of the infected plants of tobacco could cause infection in healthy plants and called the fluid as *Contagium vivum fluidum* (infectious living fluid). W.M. Stanley (1935) showed that viruses could be crystallised and crystals consist largely of proteins. They are inert outside their specific host cell. Viruses are obligate parasites.

In addition to proteins, viruses also contain genetic material, that could be either RNA or DNA. No virus contains both RNA and DNA. A virus is a nucleoprotein and the genetic material is infectious. In general, viruses that infect plants have single stranded RNA and viruses that infect animals have either single or double stranded RNA or double stranded DNA. Bacterial viruses or bacteriophages (viruses that infect the bacteria) are usually double stranded DNA viruses (Figure 2.6b). The protein coat called capsid made of small subunits called capsomeres protects the nucleic acid. These capsomeres are arranged in helical or polyhedral geometric forms. Viruses cause diseases like mumps, small pox, herpes and influenza. AIDS in humans is also caused by a virus. In plants, the symptoms can be mosaic formation, leaf rolling and curling, yellowing and vein clearing, dwarfing and stunted growth.

Viroids (PSTV)

- In 1971 - T.O Diener - Discover Another infectious material

- Viroids ⟶ no protein cover, only genetic material
  - → Single strand RNA — circular - infectious
  - → Low molecular weight

Disease cause - PSTD (Potato spindle tuber Disease)

spindle shape

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Viroids In 1971, T.O. Diener discovered a new infectious agent that was smaller than viruses and caused potato spindle tuber disease. It was found to be a free RNA; it lacked the protein coat that is found in viruses, hence the name viroid. The RNA of the viroid was of low molecular weight.

Prions

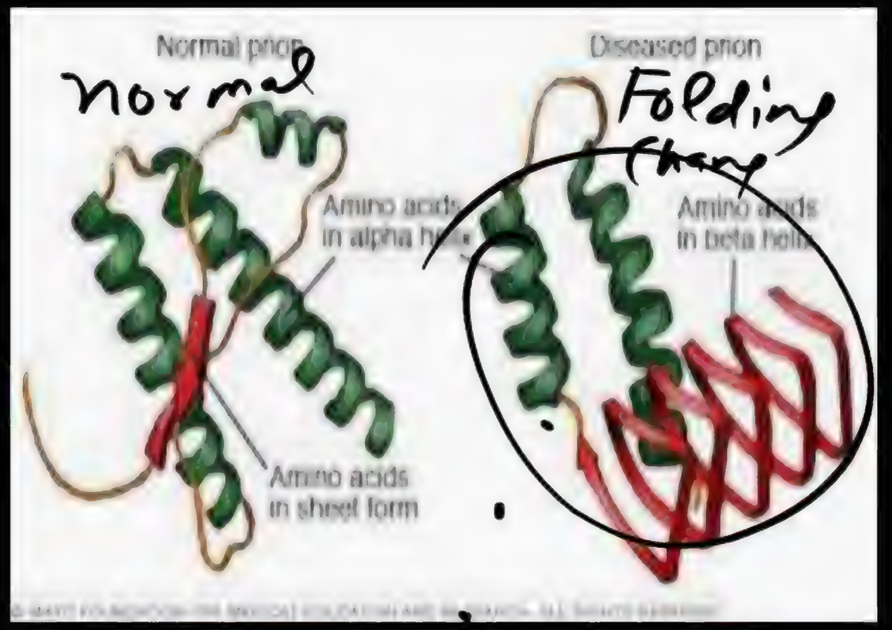
- Wrongly Folded protein which is infectious
- Responsible For - neurological Disorder

Ex- Mad cow Disease (Bovine spongiform Encephalopathy - BSE) (Bovine)

- CJD - Crutzfeldt Jacob disease or Kuru disease in Human

Virus	Viroids	Prions
Protein + nucleic Acid	nucleic Acid (SS RNA)	Proteins

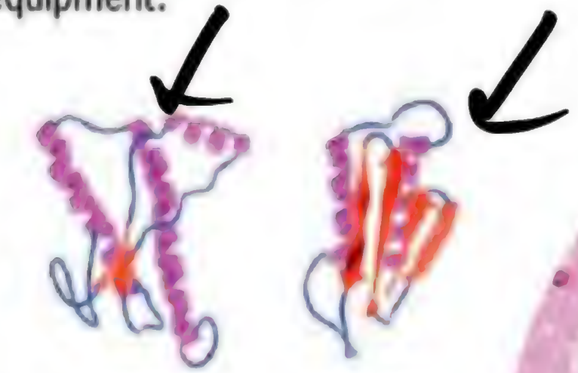
Size → Virus = Prions > Viroids



How Creutzfeldt-Jakob disease works

CAUSE

Creutzfeldt-Jakob disease is caused by abnormal proteins called prions that are not killed by standard methods for sterilizing surgical equipment.



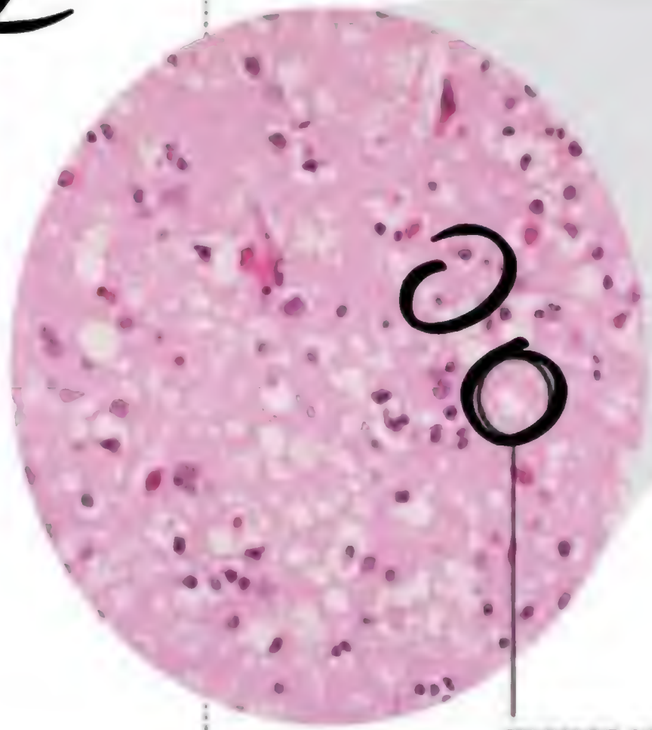
NORMAL HUMAN PROTEIN

DISEASE-CAUSING PRION

As prions build up in cells, the brain slowly shrinks and the tissue fills with holes until it resembles a sponge.

CONSEQUENCES

Those affected lose the ability to think and to move properly and suffer from memory loss. It is always fatal, usually within one year of onset of illness.



SPONGE-LIKE LESION

BRAIN SHRINKS

Prions : In modern medicine certain infectious neurological diseases were found to be transmitted by an agent consisting of abnormally folded protein. The agent was similar in size to viruses. These agents were called prions. The most notable diseases caused by prions are bovine spongiform encephalopathy (BSE) commonly called mad cow disease in cattle and its analogous variant Cr–Jacob disease (CJD) in humans.

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lichens

- Symbiotic association of Algae & Fungi

Algae → Phycobiont → Produce Food (Single cell Algae)

Fungi is known as - Mycobiont → give shelter, Absorb water & Mineral]

Important points → (a) Fungi is 90% of lichen

(b) Lichen Grow slow ⟶ Grow in non-polluted Area (Mountain)

(c) Sulfur dioxide pollution - Slow Growth of lichen - So lichen is pollution indicater)

(d) Produce litmus

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Biological Classification

lecture - 09

Botany

TARUN SIR

Topics

Kingdom of classification – Biological Classification

System of classification → Plant Kingdom

} Related

cell theory

Classification of organism - Grouping of organism Suitable categor

Earlier system → Not scientific

Based on need → Food, shelter, cloth

(In Earlier civilization)

First scientific of classification → Aristotle

Basis → Gross Morphology (External structure)

Plant classify into → (a) Herb → Ex - Grass, tomato (Always Green, small plant)

(b) Shrub → Ex - Citrus, Rose (Stem Brown never trunk)

(c) tree → Ex - Neem, Mango (thick stem (trunk)

Animals classify → (a) With RBC (Enaima)

(b) Without RBC (Anaima)

Since the dawn of civilisation, there have been many attempts to classify living organisms. It was done instinctively not using criteria that were scientific but borne out of a need to use organisms for our own use – for food, shelter and clothing. Aristotle was the earliest to attempt a more scientific basis for classification. He used simple morphological characters to classify plants into trees, shrubs and herbs. He also divided animals into two groups, those which had red blood and those that did not.

Kingdoms of Classification (Another scientific)

I Two kingdom classification – all organism are Grouped into Either of the two kingdom – Plantae, Animalia (By Linnaeus)

living organism → Basis → Cell wall

Plantae Cell wall present
- Algae, Bryophyte, Pteridophyte, Gymnosperm Angiosperm
- Diatom, Dinoflagellates ✓
- → Bacteria, Cyanobacteria, Archaebacteria ✓
- → Fungi ✓

Animalia – Cell wall Absent
- → Sponges, Fish, Insect, Mammals, Birds
- – Protozoa (Amoeba, Paramoecium)

note – This classification was Found to be Inadequate

Drawback — (a) Prokaryote & Eukaryote same Kingdom.
(b) Autotrophic (Plants) & Heterotrophic (Fungi) same Group
(c) Unicellular & Multicellular same Group (Diatom, Bacteria)
(d) Simple thallus (Algae, Fungi) with Advance organism (Angiosperm)

Fungi

Q1 In two Kingdom Classification, Ustilago is in
(a) Protista (b) Fungi (c) Plantae (d) Monera

Q2 In two Kingdom Classification, Amoeba is in ——— Kingdom
(a) Protista (b) Protozoa (c) Plantae (d) Animalia

note – With changing understanding with times, members in Plantae & Animalia shifted to other Kingdom & Plant & Animal Kingdom name Remain same

note – Beside Gross morphology, other Feature was also included in upcoming Kingdoms.

In Linnaeus' time a **Two Kingdom** system of classification with **Plantae** and **Animalia** kingdoms was developed that included all plants and animals respectively. This system did not distinguish between the eukaryotes and prokaryotes, unicellular and multicellular organisms and photosynthetic (green algae) and non-photosynthetic (fungi) organisms. Classification of organisms into plants and animals was easily done and was easy to understand, but, a large number of organisms did not fall into either category. Hence the two kingdom classification used for a long time was found inadequate. Besides, gross morphology a need was also felt for including other characteristics like cell structure, nature of wall, mode of nutrition, habitat, methods of reproduction, evolutionary relationships, etc. Classification systems for the living organisms have hence, undergone several changes over the time. Though plant and animal kingdoms have been a constant under all different systems, the understanding of what groups/organisms be included under these kingdoms have been changing; the number and nature of other kingdoms have also been understood differently by different scientists over the time.

Few Examples are Given

Bacter P A A
Streptococcus, Albugo, Gonbylaux, Parmoecium, Pila, Ascaris
P Fny P
Spirogyra, Pinus

- Plant kingdom → 5
- Animal kingdom 3

Three Kingdom (Ernst Haeckel)

↓ Two Kingdom Problem - Fungi, Bacteria, Unicellular not well placed

Plantae

Animalia

Protista

Fungi

Protozoa

Bacteria, Cyanobacteria, Archaebacteria, Diatom, Dinoflagellates

---

Four Kingdom (Copeland)

(Drawback - Fungi not properly placed)

Plantae

Fungi

Animalia

Protista

Unicellular Eukaryotes (Diatom, Dinoflagellates, Euglenoids, Protozoa)

Monera - Prokaryotes

Cyanobacteria, Archaebacteria

Few Examples are Given

F-1 B-2 B-3 A-4 B-5 P-6 P-7
Rhizopus, Streptococcus, nostoc, Earthworm, Methanogen, Cycas, Neem

A-8 A-9
Corvus (कौआ), Cow

Q1 How many in plantae
- two kingdom → 1, 2, 3, 5, 6, 7 = 6
- three kingdom → 6, 7 ⇒ 2
- Four kingdom → 1, 6, 7 ⇒ 3

Q2 How many are in protista
- two kingdom — X
- Three kingdom → 1, 2, 3, 5, ⇒ 4
- Four kingdom → 0

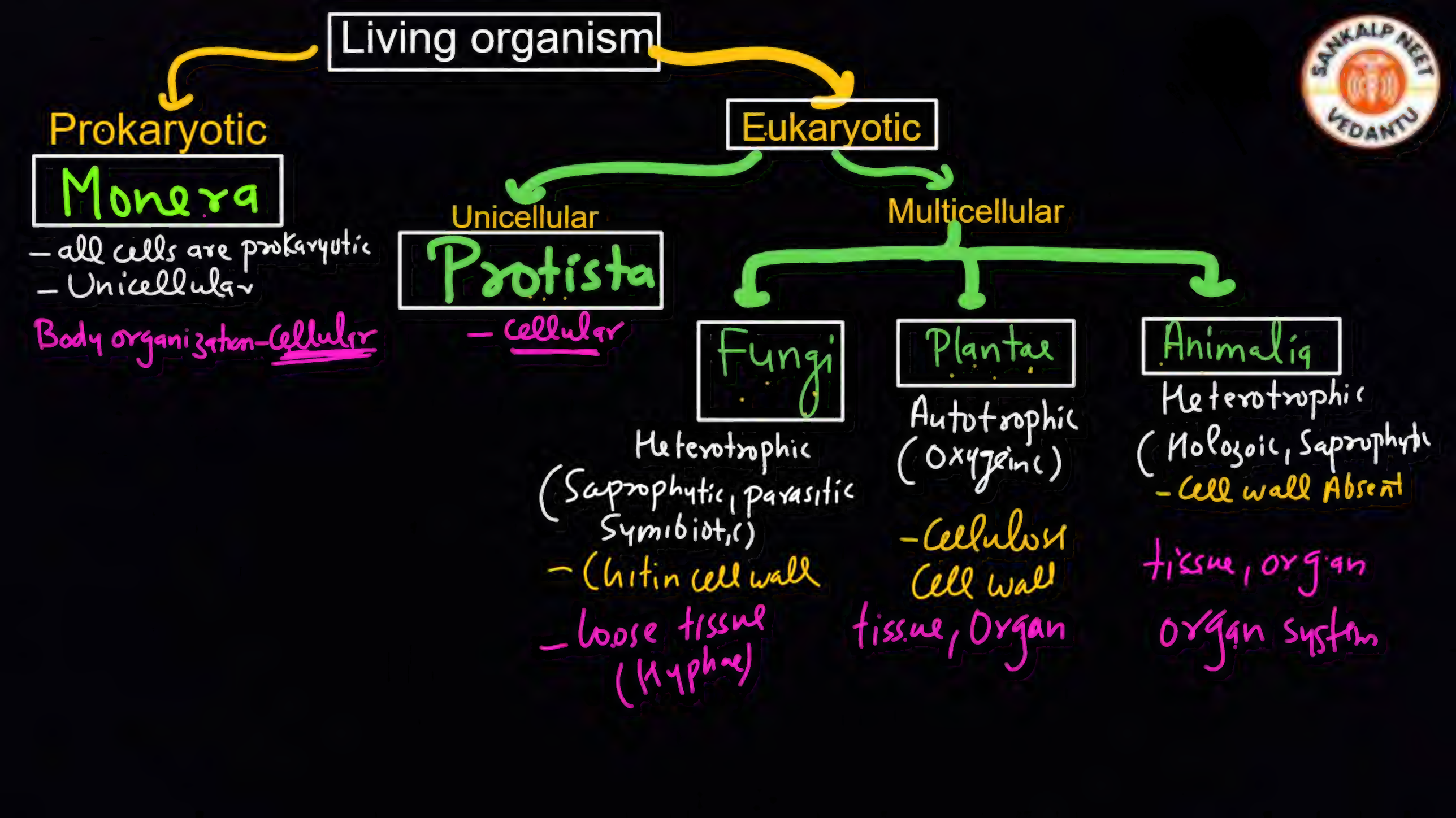
Five Kingdom of Classification

(1969 - R.H Whittaker → Fungi seperate kingdom

Monera | Protista | Fungi | plantae | Animalia

Basis — cell structure
- thallus organization / Body organization
- mode of nutrition
- Reproduction
- Phylogenetic Relationship
(Evolutionary Relationship)

R.H. Whittaker (1969) proposed a **Five Kingdom Classification**. The kingdoms defined by him were named **Monera, Protista, Fungi, Plantae** and **Animalia**. The main criteria for classification used by him include cell structure, body organisation, mode of nutrition, reproduction and phylogenetic relationships. Table 2.1 gives a comparative account of different characteristics of the five kingdoms.


Living organism
Prokaryotic
Monera
– all cells are prokaryotic
– Unicellular
Body organization-Cellular
Eukaryotic
Unicellular
Protista
– cellular
Multicellular
Fungi
Heterotrophic
(Saprophytic, parasitic
Symbiotic)
– Chitin cell wall
– loose tissue
(Hyphae)
Plantae
Autotrophic
(Oxygenic)
– Cellulose
Cell wall
tissue, Organ
Animalia
Heterotrophic
(Holozoic, Saprophytic
– Cell wall Absent
tissue, organ
organ system
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Characters	Five Kingdoms				
	Monera	**Protista**	**Fungi**	**Plantae**	**Animalia**
Cell type	Prokaryotic	Eukaryotic	Eukaryotic	Eukaryotic	Eukaryotic
Cell wall	Noncellulosic (Polysaccharide + amino acid)	Present in some (Diatom, Dinoflagel)	Present with chitin	Present (cellulose)	Absent
Nuclear membrane	Absent	Present	Present	Present	Present
Body organisation	Cellular	Cellular	Multicellular/ loose tissue	Tissue/ organ	Tissue/organ/ organ system
Mode of nutrition	Autotrophic (chemosynthetic and photosynthetic) and Heterotrophic (saprophytic/parasitic)	Autotrophic (Photosynthetic) and Heterotrophic	Heterotrophic (Saprophytic/ Parasitic), Symb.	Autotrophic (Photosynthetic) Oxygenic	Heterotrophic (Holozoic/ Saprophytic etc.)

Peptidoglycan
NAG NAM
Anoxy Oxy Chemo Parasitic Sapro By

Q How many Kingdom have Autotrophic ⟶ (M, P, P)

(a) two (b) three (c) Four (d) Five

Q How many Kingdom have only Autotrophic (P)

(a) one (b) three (c) Four (d) Five

Q How many Kingdom is Multicellular (Fungi, Plantae, Animal)

(a) two (b) three (c) Four (d) Five

Explanation of Five kingdom

① → all prokaryotes is in Monera (Earlier → Bacteria, Cyanobacteria (BGA → is in Plantae)

② All Unicellular Eukaryotes in Protista (Chlamydomonas, Chlorella, Spirogyra) → Earlier all three in Algae and in plantae

But in Five Kingdom classification Chlamydomonas & Chlorella in protista

③ Spirulina (Cyanobacteria) Earlier in Algae
Since it is prokaryotic, it is placed in Monera

④ Amoeba Earlier in Animal Kingdom, now in Protista.

Six Kingdom of classification - Scientist → (Carl woes)

- Basis → 16 s rRNA

Life / living organism

- Domain I → Prokarya - Kingdom [Eubacteria] (1)
- Domain II → Archaeya - Kingdom [Archaebacteria] (2)
- Domain III → Eukarya → Eukaryotes
  - Protista (3)
  - Fungi (4)
  - Plantae (5)
  - Animalia (6)

Q Which is largest category

(a) Class (b) Kingdom (c) Phylum (d) Domain ✓

The three-domain system has also been proposed that divides the Kingdom Monera into two domains, leaving the remaining eukaryotic kingdoms in the third domain and thereby a six kingdom classification. You will learn about this system in detail at higher classes.

Let us look at this five kingdom classification to understand the issues and considerations that influenced the classification system. Earlier classification systems included bacteria, blue green algae, fungi, mosses, ferns, gymnosperms and the angiosperms under 'Plants'. The character that unified this whole kingdom was that all the organisms included had a cell wall in their cells. This placed together groups which widely differed in other characteristics. It brought together the prokaryotic bacteria and the blue green algae (cyanobacteria) with other groups which were eukaryotic. It also grouped together the unicellular organisms and the multicellular ones, say, for example, *Chlamydomonas* and *Spirogyra* were placed together under algae. The classification did not differentiate between the heterotrophic group – fungi, and the autotrophic green plants, though they also showed a characteristic difference in their walls composition – the fungi had chitin

in their walls while the green plants had a cellulosic cell wall. When such characteristics were considered, the fungi were placed in a separate kingdom – Kingdom Fungi. All prokaryotic organisms were grouped together under Kingdom Monera and the unicellular eukaryotic organisms were placed in Kingdom Protista. Kingdom Protista has brought together *Chlamydomonas*, *Chlorella* (earlier placed in Algae within Plants and both having cell walls) with *Paramoecium* and *Amoeba* (which were earlier placed in the animal kingdom which lack cell wall). It has put together organisms which, in earlier classifications, were placed in different kingdoms. This happened because the criteria for classification changed. This kind of changes will take place in future too depending on the improvement in our understanding of characteristics and evolutionary relationships. Over time, an attempt has been made to evolve a classification system which reflects not only the morphological, physiological and reproductive similarities, but is also phylogenetic, i.e., is based on evolutionary relationships.

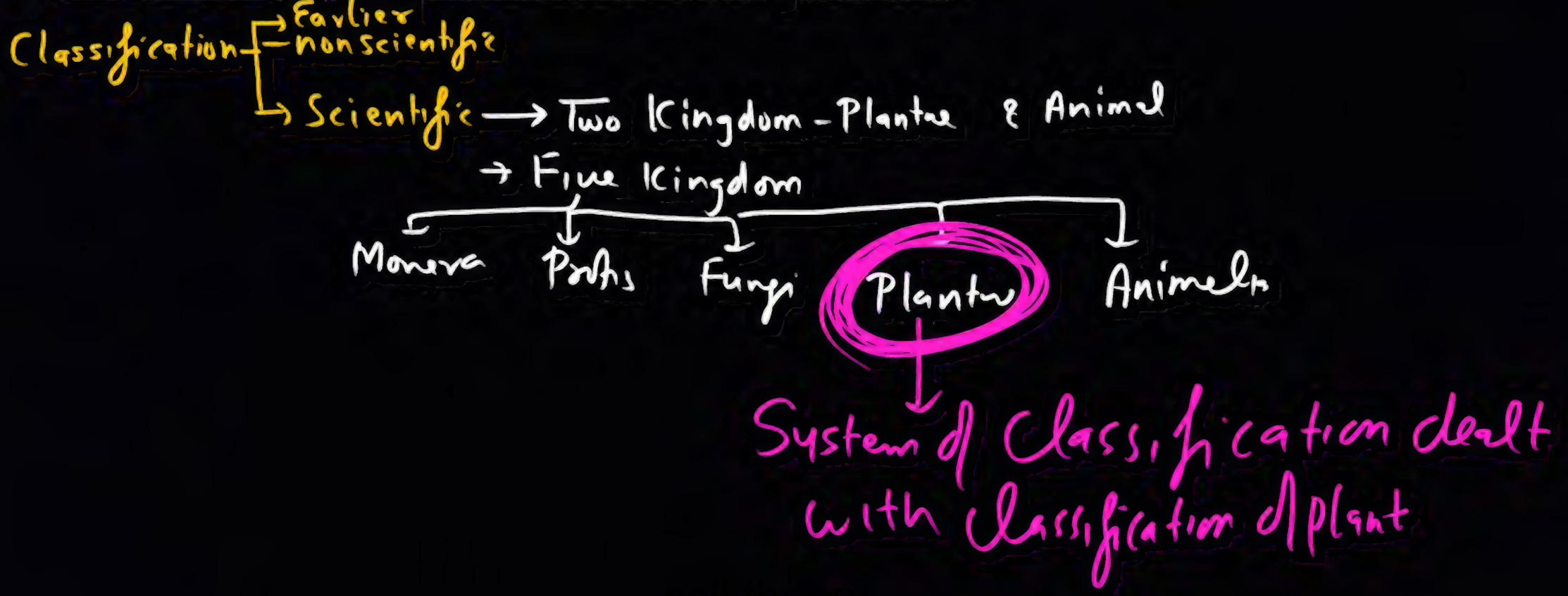
In this chapter we will study characteristics of Kingdoms Monera, Protista and Fungi of the Whittaker system of classification. The Kingdoms Plantae and Animalia, commonly referred to as plant and animal kingdoms, respectively, will be dealt separately in chapters 3 and 4.

cell theory

cell theory

System of Classification

We dealt with classification in plantae



In the previous chapter, we looked at the broad classification of living organisms under the system proposed by Whittaker (1969) wherein he suggested the Five Kingdom classification viz. Monera, Protista, Fungi, Animalia and Plantae. In this chapter, we will deal in detail with further classification within Kingdom Plantae popularly known as the 'plant kingdom'.

How classification Changed

Two Kingdom → Plantae – Fungi → (Position of Fungi change)
- Animalia

three kingdom
- Plantae
- Protista → Fungi
- Animalia

Five Kingdom → Fungi separate kingdom

Plant Kingdom – In Five Kingdom classification
- Algae
- Bryophyte
- Pteridophyte
- Gymnosperm
- Angiosperm

Plant Kingdom

Algae Bryophytes Pteridophytes Gymnosperm Angiosperm

* These Five Group is in plant Kingdom
* Some classification method ⟶ in Angiosperm
* System of Classification - it is Basically classification System in Angiosperm

Three system of Classification

(a) Artificial system (b) Natural system (c) Phylogenetic system

We must stress here that our understanding of the plant kingdom has changed over time. Fungi, and members of the Monera and Protista having cell walls have now been excluded from Plantae though earlier classifications placed them in the same kingdom. So, the cyanobacteria that are also referred to as blue green algae are not 'algae' any more. In this chapter, we will describe Algae, Bryophytes, Pteridophytes, Gymnosperms and Angiosperms under Plantae .

Artificial system

→ It is Based on – Gross morphology → Colour & shape of leaf
→ Given By Carolus linnaeus

Why it is Artificial – Based on Single Feature, Group appear to artificial
(Organism not with many Similarity – come together

Ex – Group Acc. to number of Androecium

Drawback → @ Unrelated come together
(6) Vegetative & Reproductive Feature given same weightage
(more weightage Should be Reproductive character
as vegetative change Easily with Environment))

Let us also look at classification within angiosperms to understand some of the concerns that influenced the classification systems. The earliest systems of classification used only gross superficial morphological characters such as habit, colour, number and shape of leaves, etc. They were based mainly on vegetative characters or on the androecium structure (system given by Linnaeus). Such systems were **artificial;** they separated the closely related species since they were based on a few characteristics. Also, the artificial systems gave equal weightage to vegetative and sexual characteristics; this is not acceptable since we know that often the vegetative characters are more easily affected by environment. As against this, **natural classification systems** developed, which were based on natural affinities among the organisms and consider.

Natural system

[Other than morphology → more Charackers For Classification

Other characters → like Embryology, Phytochemistry, Anatomy, Cell Ultrastructure

– Group appear to be natural

Ex- Bentham & Hookar – Classification of Angiosperm

vegetative and sexual characteristics; this is not acceptable since we know that often the vegetative characters are more easily affected by environment. As against this **natural classification systems** developed, which were based on natural affinities among the organisms and consider,

not only the external features, but also internal features like ultra-structure, anatomy, embryology and phytochemistry. Such a classification for flowering plants was given by George Bentham and Joseph Dalton Hooker.

phylogenetic System

→ Organism belonging to same Group (taxa) have common Ancestor

→ Study of phylogenic possible - By - Fossils

→ But if Fossils not present other method help

(a) Numerical taxonomy

(b) Cytotaxonomy

(c) Chemotaxonomy

At present **phylogenetic classification systems** based on evolutionary relationships between the various organisms are acceptable. This assumes that organisms belonging to the same taxa have a common ancestor. We now use information from many other sources too to help resolve difficulties in classification. These become more important when there is no supporting fossil evidence. **Numerical Taxonomy** which is

Numerical

- Character → given code → Store in computer

→ all Characters Equal code → when compar with the help of computer — whether they have Common Ancestor

there is no supporting fossil evidence. **Numerical Taxonomy** which is now easily carried out using computers is based on all observable characteristics. Number and codes are assigned to all the characters and the data are then processed. In this way each character is given equal importance and at the same time hundreds of characters can be considered.

② Cytotaxonomy | Karyotaxonomy

→ In this compare Chromosome number, Structure & behaviour

considered. **Cytotaxonomy** that is based on cytological information like chromosome number, structure, behaviour and

③ Chemotaxonomy – Compare chemicals in plant to Find similarity

l **chemotaxonomy** that uses the chemical constituents of the plant to resolve confusions, are also used by taxonomists these days.

MANTHAN NEET 2025 -

Plant kingdom

lecture - 1

Botany

TARUN SIR

Topics

- Algae
- Bryophyte
- pteridophyte
- Gymnosperm
- Angiosperm

no of Question + 3 → 12 Marks

SANKALP NEET VEDANTU

Today's Goal

Basics of Algae

cell theory

Important Examples

Green Algae — Chlamydomonas, Chlorella, Spirogyra, ulothrix, Chara, Cladophora, Volvox, Eudorina

Brown Algae — Ectocarpus, Kelp, Laminaria, Sargassum, Fucus, Dictyota

Red Algae — Polysiphonia, Gelidium, Gracilaria, Porphyra

Phycoerythrin — (Red Algae)

Q1 Phycoerythrin present in

(a) Volvox (b) Ulothrix (c) Fucus (d) Gelidium

II

Bryophytes

- Liverworts → Marchantia ←
- Moss → Sphagnum, Polytrichum, Funaria

III

Pteridophytes

Fern

1. Psilopsida → - Psilotum ✓
2. Pteropsida - Pteris, Dryopteris, Adiantum, Azolla, Salvinia
3. Sphenopsida - Equisetum (Horse tail)
4. Lycopsida - Selaginella, Lycopodium

IV

Gymnosperm →

Conifers - Pinus, Cedrus
- Cycas
- Sequoia, Ginkgo (tallest tree)

Q Which is Pteridophyte

(a) Ginkgo (b) Salvinia (c) Sphagnum (d) Fucus

Q2 Few Ex. are given

Fucus (B.A), Funaria (Br), Sphagnum (Br), Selaginella (Pt), Sequoia (Gy), Porphyra (R.A), Pinus (Gym)

Chlorella (G.A), Cycas (Gym), Equisetum (Pt), Ginkgo (Gym)

- Pteridophyte 2
- Gymno - 4
- Bryo - 2
- Algae - 3

G.A → 1

B.A - 1

R.A - 1

Q Few Ex are given

R.A Pt Pt Bry B.A B.A
Polysiphonia, Psilotum, Pteris, Funaria, Dictyota, Laminaria

G.A Gym Gym Ang Ang R.A Pt
Volvox, Sequoia, Pinus, Neem, Rose, Gelidium, Lycopodium

Algae - 5
Bryo - 1
Pte - 3
Gym - 2
Ang - 2

G.A - 1
B.A 2
R.A - 2

Algae

Topics need to study

1. → Habitat
2. → Structure
3. → Nutrition → not study in detail – Oxygenic photosynthesis (Entire plant Kingdom Show only this)
4. → Reproduction
5. → Importance
6. → Classification of Algae
   - Chlorophyceae – Green Algae
   - Phaeophyceae – Brown Algae
   - Rhodophyceae – Red Algae

Basics of Algae

[Alga - Single
Algae - Plural]

① It is chlorophyll bearing = Photosynthetic

② Eukaryotic, mostly multicellular Algae (Few Unicellular Algae
Chlamydomonas, Chlorella)

③ thalloid → no proper shape

→ no proper Root, stem, & leaf] Shape → thallus like

④ Mostly Aquatic]

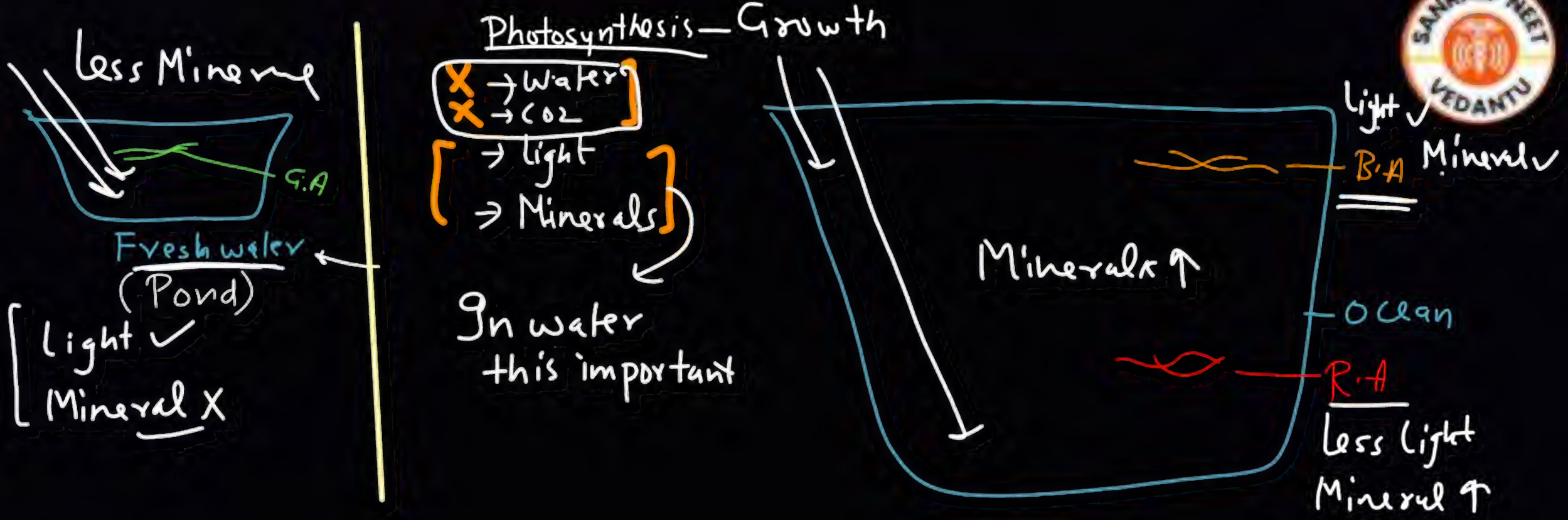
Habitat

- Most Aquatic
  - Fresh water
    - Stagnant (Pond water)
    - Flowing (River)
  - Marine (Flowing) (deep sea, Brackish water, warm water)

Some Algae Also Found ⟶
① Brackish water (Fresh mix with marine)
② Moist stone
③ on wood (moist)
④ Snow
⑤ deep sea (Problem - Light less)
⑥ On sloth bear - (Grow on Animals)
⑦ On lichen

Green Algae - Mostly Fresh water
Brown Algae - Marine
Red Algae - Mostly Marine → deep sea, Warm water

Q1 Which Algae Grow in maximum size
(a) Green Algae (b) Brown Algae
(c) Red Algae (d) all


Less Mineral
G.A
Freshwater
(Pond)
[Light ✓
Mineral X
Photosynthesis → Growth
[X → Water
X → CO2]
[→ light
→ Minerals]
In water
this important
Light ✓
B.A
Mineral ✓
Minerals ↑
Ocean
R.A
Less Light
Mineral ↑

Structure of Algae

→ Algae is thalloid

Two topic study – ① External structure ② Cell detail

External structure – Algae show Range/variable Form & Size

Different Form of Algae – Different shape

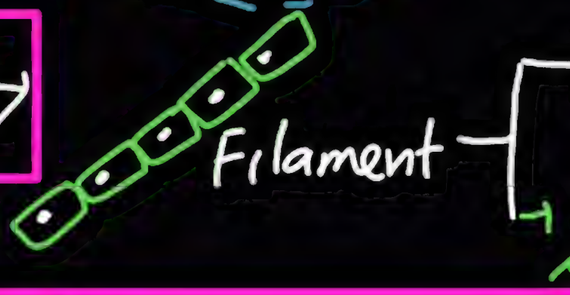
(a) Unicellular Algae → only Example in Green Algae →

Chlamydomonas (motile)
Chlorella (non-motile)

(b) Colonial Algae →

Example – Voluox.

(c) Filamentous (most common) →



Filament →
- → Unbranch → Ex- Spirogyra, Ulothrix
- → Branch – Ex- Cladophora

→ Broun Algae → maximum Size
→ Red Algae

Q Colonial Algae is
(a) Voluox (b) Chlamydomonas (c) Spirogyra
(d) Fucus

Green Algae (thallus

thallus (Red Algae)
Branch Filamentous

thallus (Brown Alg

Q1 Algae which show maximum Form
(a) G.A (b) B.A (c) R.A (d) none

Q2 Most common Form in Algae
(a) Unicellular (b) Filamentous unbranch
(c) Filamentous Branch (d) colonial

Note – Brown Algae can grow upto 100 meter or more

Holdfast
(Attachment

Q Hold Fast Absent in
(a) Fucus (b) Kelp
(c) Spirogyra (d) Gelidium
(Pond)

Detail of Algae cell (Algae cell Eukaryotic, Well defined nucleus, Membrane bound organelle)

—only study → cell wall, Pigment, Flagella, Storage

Cell wall → Rigid structure, main component cellulose

Green Algae → Inner cellulose outer pectin (Rigid)

Brown Algae → Cellulose + Algin

Red Algae → Cellulose + Carageen (Polysulfate Ester)

Algae cell wall — Cellulose

Q Carageen present in (R·A)

(a) Volvox (G·A) (b) Gelidium (R·A) (c) Kelp (B·A) (d) Fucus (B·A)

Q Alginic Acid present in

(a) Chlorella (G·A) (b) Porphyra (R·A) (c) Dictyota (B·A) (d) Ulothrix (G·A)

MANTHAN NEET 2025 -

SANKALP NEET VEDANTU

Plant kingdom

lecture - 2

Botany

TARUN SIR

Topics

- Algae
- Bryophyte
- pteridophyte
- Gymnosperm
- Angiosperm

2 no of Question + 3 → 12 Marks

Today's Goal

Basics of Algae

cell theory

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Green Algae — Chlamydomonas, Chlorella, Spirogyra, ulothrix, Chara, Cladophora, Volvox, Eudorina

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Red Algae — Polysiphonia, Gelidium, Gracilaria, Porphyra

Phycoerythrin — (Red Algae)

Q) Phycoerythrin present in

(a) Volvox (b) Ulothrix (c) Fucus (d) Gelidium

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- Moss → Sphagnum, Polytrichum, Funaria

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Fern

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4. Lycopsida - Selaginella, Lycopodium

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Gymnosperm →

Conifers - Pinus, Cedrus
- Cycas
- Sequoia, Ginkgo
(tallest tree)

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Chlorella (G.A), Cycas (Gym), Equisetum (Pt), Ginkgo (Gym)

- Ptérido 2
- Gymno – 4
- Bryo – 2
- Algae – 3

G.A → 1

B.A – 1

R.A – 1

cell theory

Q Few Ex are given

Polysiphonia (R.A), Psilotum (Pt), Pteris (Pt), Funaria (Bry), Dictyota (B.A), Laminaria (B.A)

Volvox (G.A), Sequoia (Gym), Pinus (Gym), Neem (Ang), Rose (Ang), Gelidium (R.A), Lycopodium (Pt)

Algae - 5

Bryo - 1

Pte - 3

Gym - 2

Ang - 2

G.A - 1

B.A 2

R.A - 2

cell theory

Algae

Topics need to study

1. → Habitat
2. → Structure ✓
3. → Nutrition → not study in detail – Oxygenic photosynthesis (Entire plant Kingdom show only this)
4. → Reproduction
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Basics of Algae

[Alga - Single
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① It is chlorophyll bearing = Photosynthetic

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③ thalloid → no proper shape

→ no proper Root, stem, & leaf] Shape → thallus like

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Habitat

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⑥ On sloth bear - (Grow on Animals)
⑦ On lichen

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Q1 Which Algae Grow in maximum size
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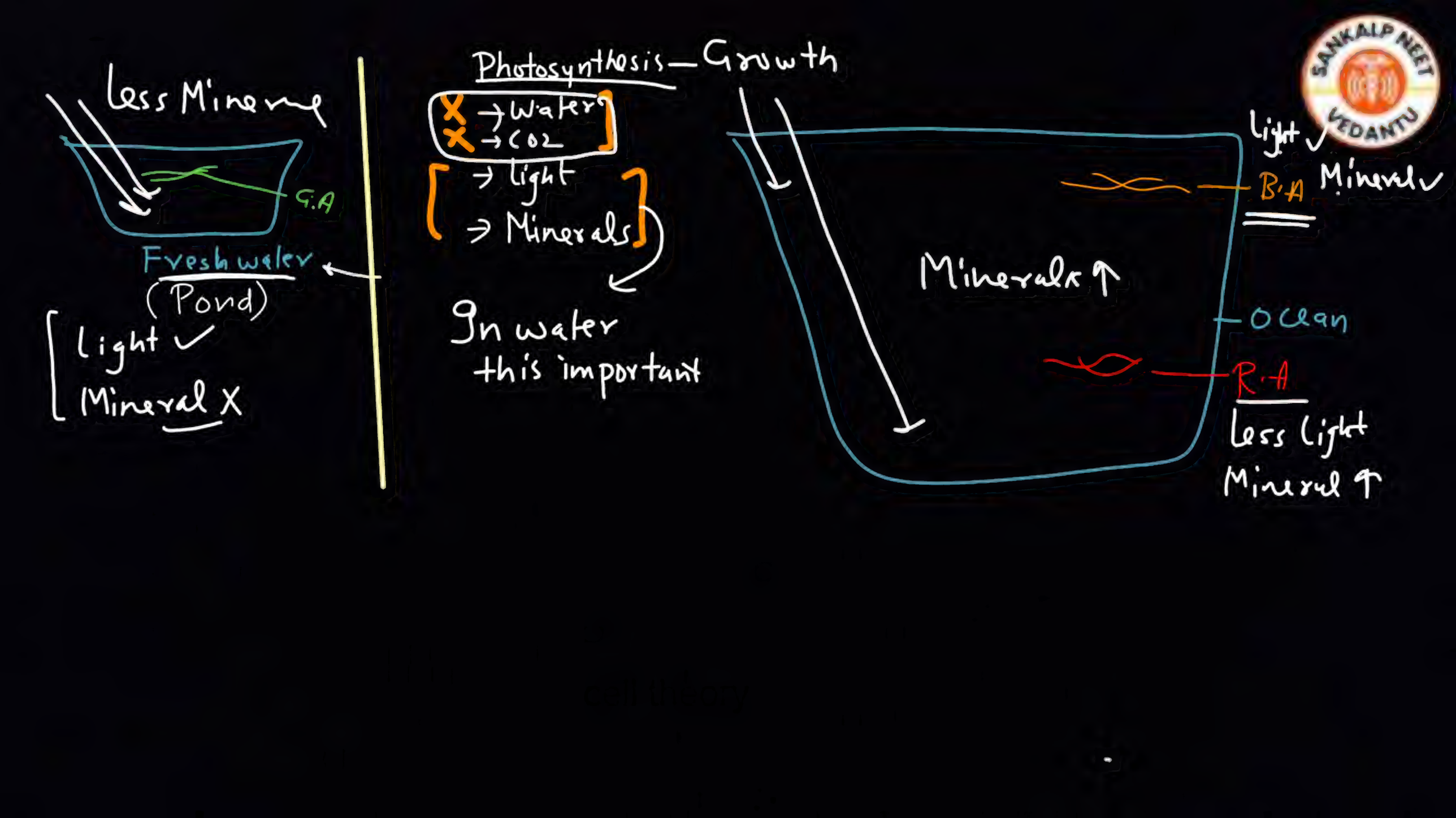

Less Mineral
G.A
Freshwater
(Pond)
Light ✓
Mineral X
Photosynthesis → Growth
→ Water
→ CO2
→ Light
→ Minerals
In water this important
Light ✓
B.A
Mineral ✓
Minerals ↑
Ocean
R.A
Less Light
Mineral ↑
SANKALP NEET VEDANTU

Structure of Algae

→ Algae is thalloid

→ Two topic study – ① External structure ② Cell detail

External structure

– Algae show Range/variable Form & Size

Different Form of Algae – Different shape

(a) Unicellular Algae → only Example in Green Algae →

Chlamydomonas (motile)
Chlorella (non-motile)

(b) Colonial Algae →

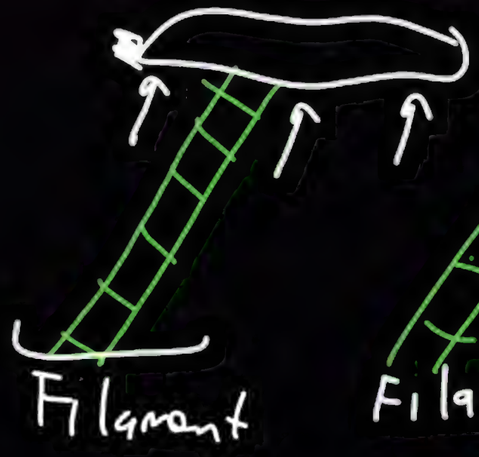
Example – Voluox.

(c) Filamentous (most common) →

Filament →
- → Unbranch → Ex- Spirogyra, Ulothrix
- → Branch – Ex- Cladophora

→ Brown Algae → maximum Size
→ Red Algae

Q Colonial Algae is
(a) Voluox (b) Chlamydomonas (c) Spirogyra
(d) Fucus



Q1 Algae which show maximum Form

(a) G:A (b) B:A (c) R:A (d) none

Q2 Most common Form in Algae

(a) Unicellular (b) Filamentous unbranch

(c) Filamentous Branch (d) Colonial

Note – Brown Algae can grow upto 100 meter or more

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(Attachment

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(Pond)

cell theory

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Algae cell wall — Cellulose

Q Carageen present in R·A

(a) Volvox G·A (b) Gelidium R·A (c) Kelp B·A (d) Fucus B·A

Q Alginic Acid present in

(a) Chlorella G·A (b) Porphyra R·A (c) Dictyota B·A (d) Ulothrix G·A

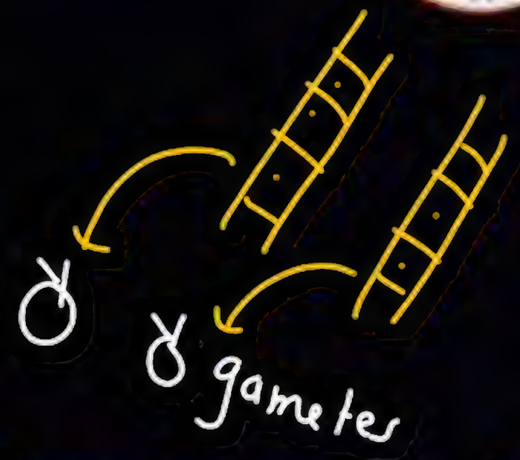
Flagella

Algae Aquatic → normally have Flagella (9+2 type)

- Algae Flagella present in (a) Asexual spore (b) Gametes

Zoospore (Asexual spore)

Flagella = Motile



Green Algae → 2-8 Flagella → Apical, Equal — [Exception – Spirogyra – non-motile

Brown Algae → 2 Flagella, Unequal, lateral →

Red Algae – no Flagella (not in gametes, not in Asexual spore (non-motile, Aplanospore)

Q Few Example – Kelp (B.A), Ectocarpus (B.A), Ulothrix (G.A), Porphyra (R.A), Gelidium (R.A), Chlamydomonas (G.A)

How many have → (a) Algin – 2 (b) Apical Flagella – 2 (c) Motile zoospore (G.A + B.A) = 4 (d) Carrageen = R.A = 2

Q1 Zoospore Absent in

(a) Albugo (Phyco) (b) Ulothrix (G.A) (c) Chlamydomonas (G.A) ~~(d) Porphyra~~ (R.A)

2 2 4 2

Q2 Aplanospore is present in ——

(a) Aspergillus (b) Polysiphonia (c) Claviceps ~~(d) all~~

R.A = non-motile

Conidia = non-mt

Pigments

- Algae have plastids → which have pigments
- All Algae have Chl a (O_2 produce → Oxygenic)
- Green Algae – Different shape → chloroplast (Cup shape, spiral, Reticulate, Disc)

Green Algae → Chl a + Chlorophyll b — note → Inside chloroplast of Green Algae Pyrenoid present

Brown Algae → Chl a + Chl c + Fucoxanthin – Brown (type of Xanthophyll)

Red Algae → Chl a + Chl d + Phycoerythrin (Red Colour)

① Fucoxanthin pigment present in
(a) Volvox (b) Dictyota (c) Porphyra (d) Ulothrix

Q Carageen containing Algae not have
(a) Well defined nucleus (b) Chlorophyll (c) Flagella (d) Cell wall

storage → All Algae synthesis Food in Form of Glucose But storage Form Different

Green Algae – Store starch (mainly) + oil

Brown Algae – laminarian starch and Mannitol (derive From Mannose)

Red Algae – Floridean starch (Structure Similar to Glycogen & Amylopectin)

2 3 4 7 4 22

Q Few Example are Given :- Cladophora (G·A), laminaria (B·A), Gelidium (R·A), Ectocarpus (B·A), Fucus (B·A), Gracilaria (R·A), Volvox (G·A), Ulothrix (G·A), Kelp (B·A)

How many have

(a) Carageen – R·A = 2

(b) Pyrenoid – G·A = 3

(c) laminarian starch = 4 B·A

(d) Zoospore – G·A + B·A = 7

(e) Zoospore with lateral Flagella = 4 B·A

(f) Aplanospore = R·A = 2

(g) non-motile Gamete = R·A = 2

Q Few Ex are given

B.A G.A R.A R.A G.A
Sargassum, Endoring, Gracilaria, Porphyra, Ulothrix

R.A G.A B.A G.A G.A
Polysiphonia, Cladophora, Fucus, Voluox, Chlamydomonas

How many show

① – Floridean starch – 3

② Carageen – 3 R.A

③ Laminarian starch – 2

④ Motile gamete – G.A + B.A = 7

⑤ Lateral Flagella = 2

⑥ Algin = 2

⑦ Non-motile gamete = 3

G.A → 5 R.A = 3
B.A = 2 =

3 3 2 7 2 2 3

Q Floridean starch present in

(a) Ulothrix (2) Kelp (3) Porphyra (4) Agaricus

Q Chl c present in

B·A

(a) Equal Flagell Algae G·A

R·A

(b) Algae with Floridean starch

(c) Algae with No Flagella R·A

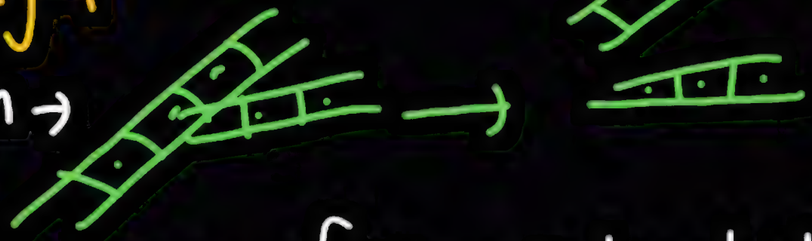
(d) Algae with mannitol

Reproduction in Algae

Algae is lower organism, Show Both Asexual & Sexual (Favorable Asexual Reproduction)

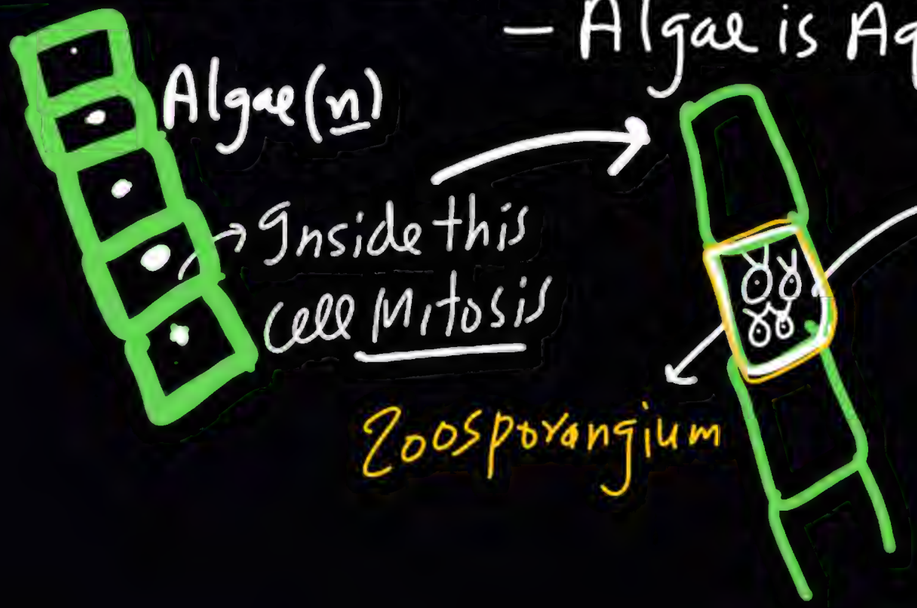
Type of Reproduction in Algae

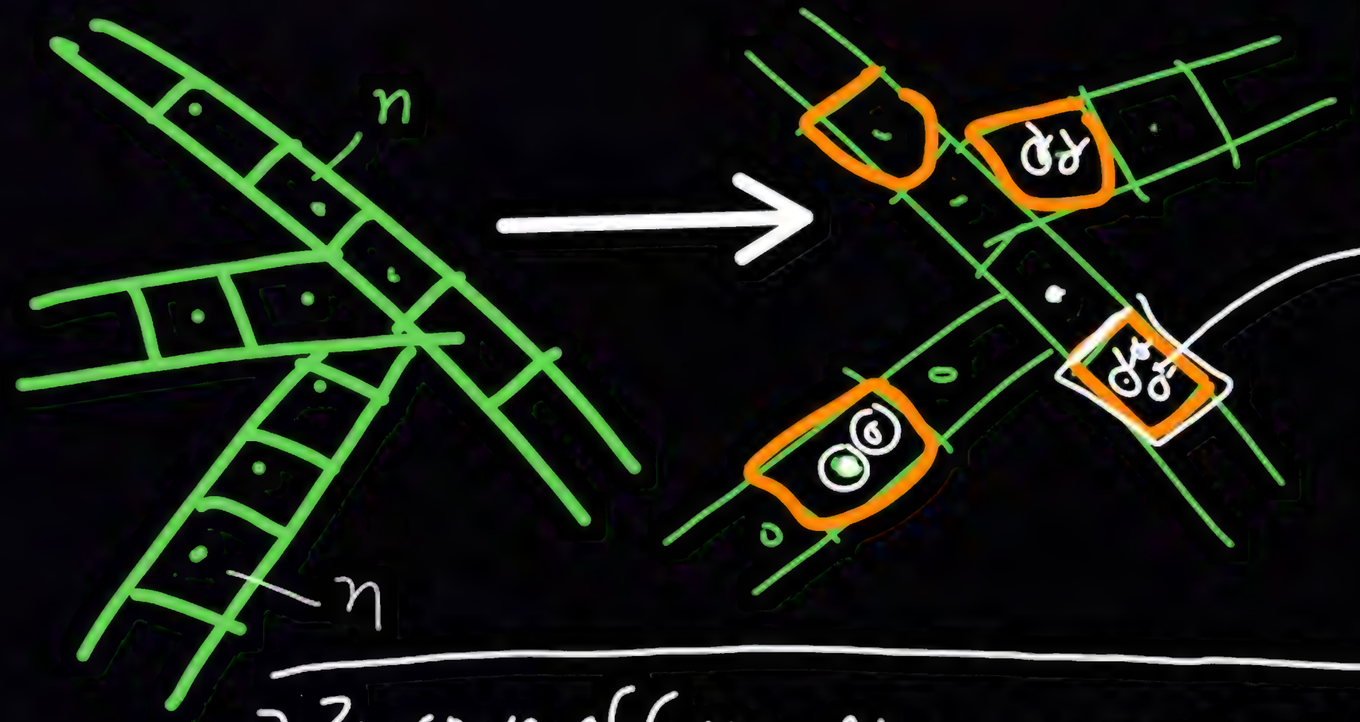
I Vegetative → Fragmentation →



II Asexual Reproductim → Spore Formation (Algae is haploid – spore produce By Mitosis)

– Algae is Aquatic → main spore is Zoospore (Except Red Algae Aplanospore)





Q Zoospore present in
(a) Pinus (b) Kelp (c) Marchantia
(d) all

Zoospore
(n)
(single)

Germination

Mitosis

→ Zoospore of Green Algae - 2-8 Flagella, Equal, Apical
→ Zoospore of Brown Algae → 2 Flagella, lateral, Unequal
→ Red Algae - Zoospore Absent, Aplanospore present

note - Zoospore in Plant Kingdom only Present in Algae
Not in Bryophyte, Pteridophyte, Gymnosperm & Angiosperm

Pear Shape Zoospore (Brown Algae)

Q Fragmentation not occur in

(a) Ulothrix (b) Porphyra (c) Chlorella (d) Kelp

rule - All Algae show Fragmentation Except unicellular Algae

Q Asexual spore present in

(a) G.A (b) B.A (c) R.A (d) all

Q Zoospore present in

(a) G.A (b) B.A (c) Both a & b (d) R.A

Q Asexual spore Absent in

(a) Bryophyte
(b) Pteridophyte
(c) Gymnosperm

(d) all

Reproduction in Algae – Sexual Reproduction in Algae

- Algae is haploid, They show true Sexual Reproduction (Form gametes & Zygote)
→ Algae produce Gametes By Mitosis (n)
→ Algae – male sex organ – Antheridium Female sex organ = Oogonium

→ **Type of Gametes**

① Isogamous → Both gamete same morphology (Genetically Different) → they can Both be motile → ♂ ♂
Both can be non-motile → ○ ○

② Anisogamous – Morphology Different → ◯ ○ or ◯ ♂

③ Oogamous → Female gamete large → non-motile → Food Reserve Present → ◯ (large) Female gamete
Male gamete small → Generally motile → → ♂ male gamete (small)

Green Algae — Isogamous, Anisogamous, Oogamous ✓
Brown Algae → Isogamous, Anisogamous, Oogamous ✓
Red Algae → only oogamous (But male gamete is also non-motile)

(a) Isogamous → Motile → Chlamydomonas, Ulothrix, Cladophora
→ non-motile — Spirogyra

(b) Anisogamous → Eudorina

(c) Oogamous → Ex - Fucus (B.A)
- Volvox (G.A)

Q Few Ex - Fucus, Volvox, Ulothrix, Porphyra, Eudorina, Gelidium (R.A)

How many oogamous
(a) three (b) four (c) Fix (d) six

Q non-motile gamete present in
(a) Kelp (b) Ulothrix
(c) Porphyra (d) Chlamydomonas

Q Isogamous non-motile
(a) Porphyra (b) Spirogyra
(c) Fucus (d) Ulothrix-mot

DOPA -

Q1 Gelidium not have Feature :-
(a) Flagella (b) Chla (c) Phycoerthrin (d) all

Q2 Porphra and Ectocarpus have common
(a) lateral Flagella (b) life cycle (c) Chla (d) all

Q3 Which is motile
(a) Zoospore of Kelp (b) Chlorella (c) Zoospore of Gracilaria (d) all

Q4 Filamentous branch is all Except
(a) Kelp (b) Euglenoids (b) Ectocarpus (d) Cladophora

Q5 Few Ex- Chlamydomonas, Chlorella, Gracilaria, Gelidium, Porphyra

Chla & chlb present in
(a) three (b) Four (c) two (d) Five

Q6 Not true about Fucus
(a) Zygotic meiosis (b) Chl a (c) Chl c (d) Algin

Q7 Haplodiplontic plant with zoospore
(a) Marchantia (b) Kelp (c) polysiphonia (d) chlamydomonas

Q8 Diplontic life cycle present in
(a) Spermatophyte (b) Pinus (c) Fucus (d) all

Q9 Floridean starch is similar to
(a) Amylose (b) Amylopectin (c) Starch (d) Mannitol

Q10 Wrong Match
(a) Chlorella - Chl b (b) Dictyota - Mannitol
(c) Polysiphonia - Zygotic Meiosis (d) Porphyra - Aplanospore

3.1 Algae

Algae are chlorophyll-bearing, simple, thalloid, autotrophic and largely aquatic (both fresh water and marine) organisms. They occur in a variety of other habitats: moist stones, soils and wood. Some of them also occur in association with fungi (lichen) and animals (e.g., on sloth bear).

The form and size of algae is highly variable, ranging from colonial forms like *Volvox* and the filamentous forms like *Ulothrix* and *Spirogyra* (Figure 3.1). A few of the marine forms such as kelps, form massive plant bodies.

The algae reproduce by vegetative, asexual and sexual methods. Vegetative reproduction is by fragmentation. Each fragment develops into a thallus. Asexual reproduction is by the production of different types of spores, the most common being the **zoospores**. They are flagellated (motile) and on germination gives rise to new plants. Sexual reproduction takes place through fusion of two gametes. These gametes can be flagellated and similar in size (as in *Ulothrix*) or non-flagellated (non-motile) but similar in size (as in *Spirogyra*). Such reproduction is called **isogamous**. Fusion of two gametes dissimilar in size, as in species of *Eudorina* is termed as **anisogamous**. Fusion between one large, non-motile (static) female gamete and a smaller, motile male gamete is termed **oogamous**, e.g., *Volvox*, *Fucus*.

cell theory

cell theory

cell theory

cell theory

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cell theory

cell theory

cell theory

MANTHAN NEET 2025 -

Plant kingdom

lecture - 3

Botany

TARUN SIR

Topics

- Algae
- Bryophyte
- pteridophyte
- Gymnosperm
- Angiosperm

2 no of Question + 3 → 12 Marks

Today's Goal

Basics of Algae

cell theory

Important Examples

Green Algae — Chlamydomonas, Chlorella, Spirogyra, ulothrix, Chara, Cladophora, Voluox, Eudorina

Brown Algae – Ectocarpus, Kelp, Laminaria, Sargassum, Fucus, Dictyota

Red Algae — Polysiphonia, Gelidium, Gracilaria, Porphyra

Phycoerythrin – (Red Algae)

Q1 Phycoerythrin present in
(a) Voluox (b) Ulothrix (c) Fucus (d) Gelidium

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II

Bryophytes

- Liverworts → Marchantia ←
- Moss → Sphagnum, Polytrichum, Funaria

III

Pteridophytes

Fern

1. Psilopsida → - Psilotum ✓
2. Pteropsida - Pteris, Dryopteris, Adiantum, Azolla, Salvinia
3. Sphenopsida - Equisetum (Horse tail)
4. Lycopsida - Selaginella, Lycopodium

IV

Gymnosperm →

Conifers - Pinus, Cedrus
- Cycas
- Sequoia, Ginkgo
(tallest tree)

Q Which is Pteridophyte

(a) Ginkgo (b) Salvinia (c) Sphagnum (d) Fucus

Q2 Few Ex. are given

Fucus (B.A), Funaria (Br), Sphagnum (Br), Selaginella (Pt), Sequoia (Gy), Porphyra (R.A), Pinus (Gym)

Chlorella (G.A), Cycas (Gym), Equisetum (Pt), Ginkgo (Gym)

- Ptérido 2
- Gymno – 4
- Bryo – 2
- Algae – 3

G.A → 1

B.A – 1

R.A – 1

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Q Few Ex are given

Polysiphonia (R.A), Psilotum (Pt), Pteris (Pt), Funaria (Bry), Dictyota (B.A), Laminaria (B.A)

Volvox (G.A), Sequoia (Gym), Pinus (Gym), Neem (Ang), Rose (Ang), Gelidium (R.A), Lycopodium (Pt)

Algae - 5

Bryo - 1

Pte - 3

Gym - 2

Ang - 2

G.A - 1

B.A 2

R.A - 2

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Algae

Topics need to study

1. Habitat
2. Structure ✓
3. Nutrition → not study in detail – Oxygenic photosynthesis (Entire plant Kingdom Show only this)
4. Reproduction
5. Importance ←
6. Classification of Algae
   - Chlorophyceae – Green Algae
   - Phaeophyceae – Brown Algae
   - Rhodophyceae – Red Algae

Basics of Algae

[Alga - Single
Algae - Plural]

① It is chlorophyll bearing = Photosynthetic

② Eukaryotic, mostly multicellular Algae (Few Unicellular Algae Chlamydomonas, Chlorella)

③ thalloid → no proper shape

→ no proper Root, stem, & leaf] Shape → thallus like

④ Mostly Aquatic]

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Habitat

- Most Aquatic
  - Fresh water
    - Stagnant (Pond water)
    - Flowing (River)
  - Marine (Flowing) (deep sea, Brackish water, warm water)

Some Algae Also Found ⟶ ① Brackish water (Fresh mix with marine)

② Moist stone ③ on wood (moist) ④ Snow

⑤ deep sea (Problem - Light less)

(6) On sloth bear - (Grow on Animals)

⑦ In lichen

Green Algae - Mostly Fresh water

Brown Algae - Marine

Red Algae - Mostly Marine → deep sea, Warm water

Q1 Which Algae Grow in maximum size

(a) Green Algae (b) Brown Algae

(c) Red Algae (d) all

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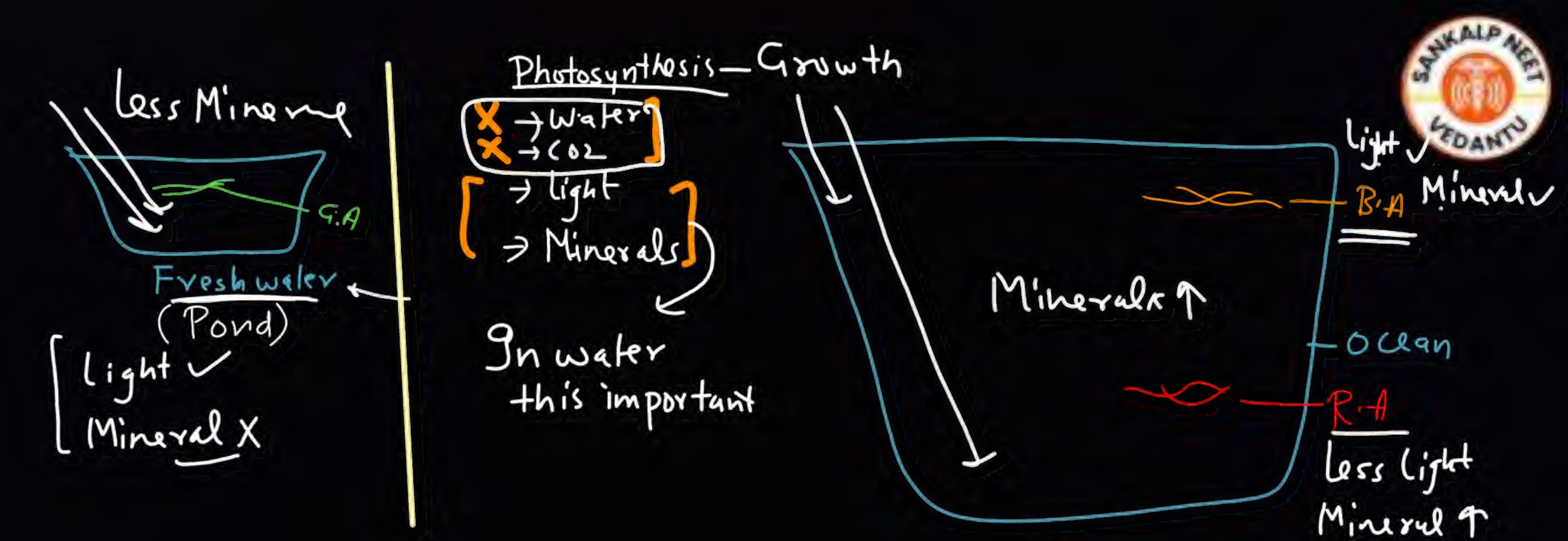
less Mineral
G.A
Fresh water
(Pond)
light ✓
Mineral X
Photosynthesis → Growth
→ water
→ CO2
→ light
→ Minerals
In water
this important
light ✓
B.A
Mineral ✓
Minerals ↑
Ocean
R.A
less light
Mineral ↑

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Structure of Algae

→ Algae is thalloid

→ Two topic study – ① External structure ② Cell detail →

External structure – Algae show Range/variable Form & Size

Different Form of Algae – Different shape

(a) Unicellular Algae → only Example in Green Algae →

Chlamydomonas (motile)
Chlorella (non-motile)

(b) Colonial Algae →

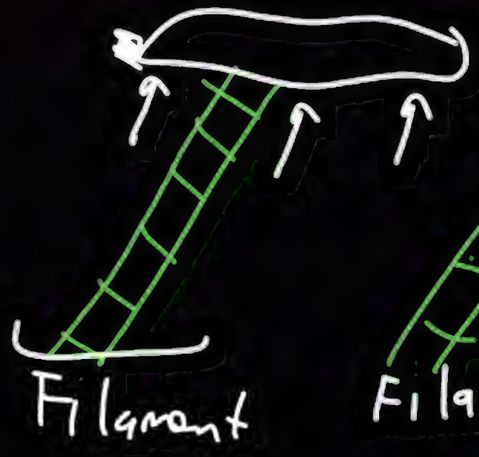
Example – Voluox

(c) Filamentous (most common) →

Filament →
- → Unbranch → Ex- Spirogyra, Ulothrix
- → Branch – Ex- Cladophora

→ Brown Algae → maximum Size
→ Red Algae

Q Colonial Algae is
(a) Voluox (b) Chlamydomonas (c) Spirogyra
(d) Fucus



Q1 Algae which show maximum Form

(a) G:A (b) B:A (c) R:A (d) none

Q2 Most common Form in Algae

(a) Unicellular (b) Filamentous unbranch

(c) Filamentous Branch (d) colonial

Note – Brown Algae can grow upto 100 meter or more

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Holdfast
(Attachment

Q Hold Fast Absent in
(a) Fucus (b) Kelp.
(c) Spirogyra (d) Gelidium
(Pond)

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Detail of Algae cell

(Algae cell Eukaryotic
well defined nucleus, Membrane bound organelle)

—only study → cell wall, Pigment, Flagella, Storage

Cell wall → Rigid structure, main component cellulose

Green Algae → Inner cellulose outer pectin
(Rigid)

Brown Algae → Cellulose + Algin

Red Algae → Cellulose + Carageen
(Polysulfate Ester)

Algae cell wall
— Cellulose

Q Carageen present in (R·A)
(a) Volvox (G·A) (b) Gelidium (R·A) (c) Kelp (B·A)
(d) Fucus (B·A)

Q Alginic Acid present in
(a) Chlorella (G·A) (b) Porphyra (R·A) (c) Dictyota (B·A) (d) Ulothrix (G·A)

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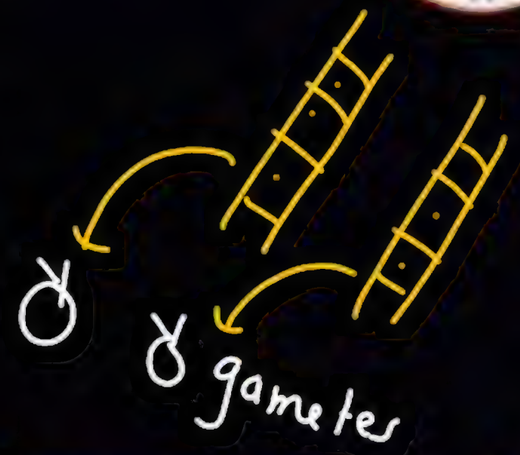
Flagella

Algae Aquatic → normally have Flagella (9+2) type)

- Algae Flagella present in (a) Asexual spore (b) Gametes

Zoospore (Asexual spore)

Flagella = Motile



Green Algae → 2-8 Flagella → Apical, Equal – [Exception – Spirogyra – non-motile

Brown Algae → 2 Flagella, Unequal, lateral →

Red Algae – no Flagella (not in gametes, not in Asexual spore (non-motile, Aplanospore)

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Q Few Example – Kelp (B.A), Ectocarpus (B.A), Ulothrix (G.A), Porphyra (R.A), Gelidium (R.A), Chlamydomonas (G.A)

How many have → (a) Algin – 2 (b) Apical Flagella – 2 (c) Motile (Zoospore) (G.A + B.A) = 4 (d) Gametangium = R.A = 2

Q1 Zoospore Absent in

(a) Albugo (Phyco) (b) Ulothrix (G.A) (c) Chlamydomonas (G.A) ~~(d) Porphyra (R.A)~~

2 2 4 2

Q2 Aplanospore is present in ——

(a) Aspergillus (b) Polysiphonia (c) Claviceps ~~(d) all~~

R.A = non-motile

Conidia = non-mt

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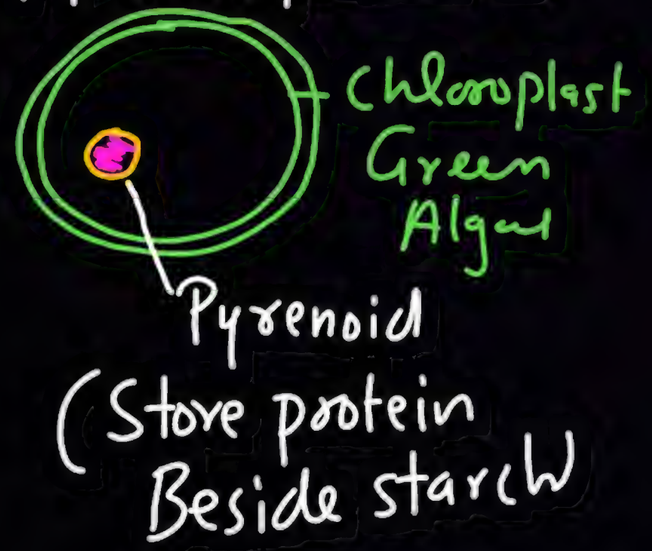
Pigments

- Algae have plastids → which have pigments
- All Algae have Chl a (O2 produce → Oxygenic)
- Green Algae – Different shape → chloroplast (Cup shape, spiral, Reticulate, Disc)

Green Algae → Chl a + Chlorophyll b — note → Inside chloroplast of Green Algae Pyrenoid present

Brown Algae → Chl a + Chl c + Fucoxanthin – Brown (type of Xanthophyll)

Red Algae → Chl a + Chl d + Phycoerythrin (Red Colour)



Q Fucoxanthin pigment present in
(a) Volvox (b) Dictyota (c) Porphyra (d) Ulothrix

Q Carageen containing Algae not have
(a) Well defined nucleus (b) Chlorophyll (c) Flagella (d) Cell wall

storage → All Algae Synthesis Food in Form of Glucose But storage Form Different

Green Algae – Store starch (mainly) + oil

Brown Algae – laminarian starch and Mannitol (derive From Mannose)

Red Algae – Floridean starch (Structure Similar to Glycogen & Amylopectin)

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Q Few Example are Given :- Cladophora (G·A), laminaria (B·A), Gelidium (R·A), Ectocarpus (B·A), Fucus (B·A), Gracilaria (R·A), Volvox (G·A), Ulothrix (G·A), Kelp (B·A)

How many have

(a) Carageen – R·A = 2

(b) Pyrenoid – G·A = 3

(c) laminarian starch = 4 B·A

(d) Zoospore – G·A + B·A = 7

(e) Zoospore with lateral Flagella = 4 B·A

(f) Aplanospore = R·A = 2

(g) non-motile Gamete = R·A = 2

Q Few Ex are given

Sargassum (B.A), Endoring (G.A), Gracilaria (R.A), Porphyra (R.A), Ulothrix (G.A)

Polysiphonia (R.A), Cladophora (G.A), Fucus (B.A), Voluox (G.A), Chlamydomonas (G.A)

How many show

(1) – Floridean starch – 3

(2) Carageen – 3 R.A

(3) laminarian starch – 2

(4) Motile gamete – G.A + B.A = 7

(5) lateral Flagella = 2

(6) Algin = 2

(7) Non-motile gamete = 3

G.A → 5 R.A = 3

B.A = 2 =

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Q Floridean starch present in

(a) Ulothrix (2) Kelp (b) Porphyra (d) Agaricus

Q Chl c present in

(a) Equal Flagell Algae — B·A

(b) Algae with Floridean starch — R·A

(c) Algae with No Flagella — R·A

(d) Algae with mannitol

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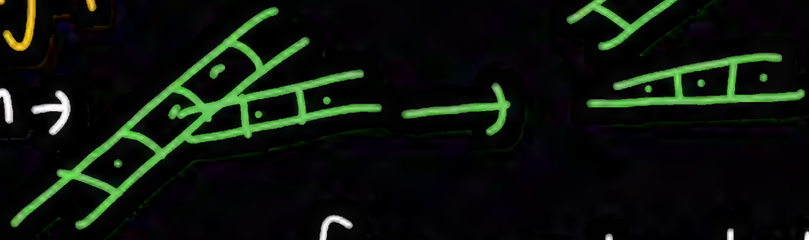
Reproduction in Algae

Algae is lower organism, Show Both Asexual & Sexual (Favorable Asexual Reproduction)

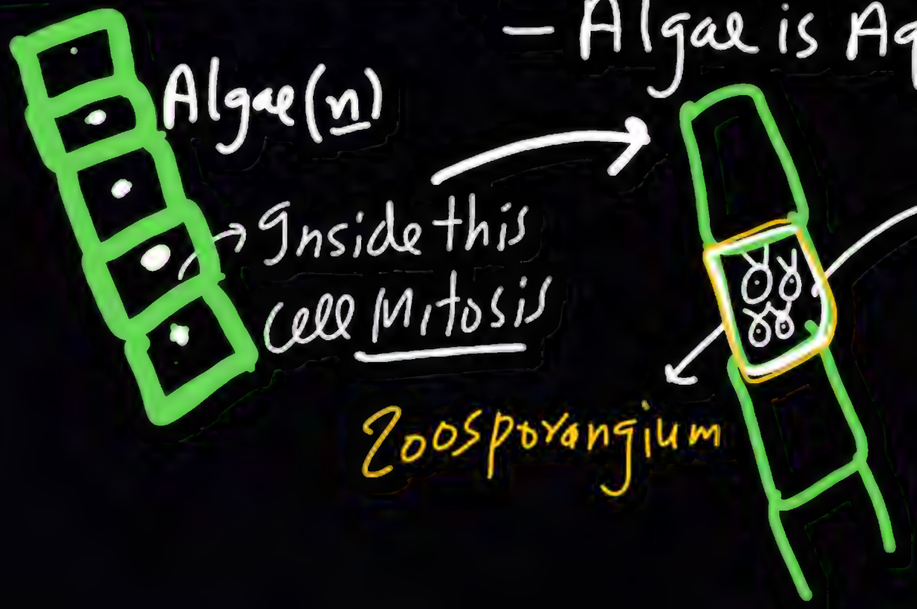
Type of Reproduction in Algae

I Vegetative → Fragmentation →



II Asexual Reproductim → Spore Formation (Algae is haploid – spore produce By Mitosis)

– Algae is Aquatic → main spore is Zoospore (Except Red Algae Aplanospore)



Mitosis

Zoospore (n) (motile)

B →

Filament

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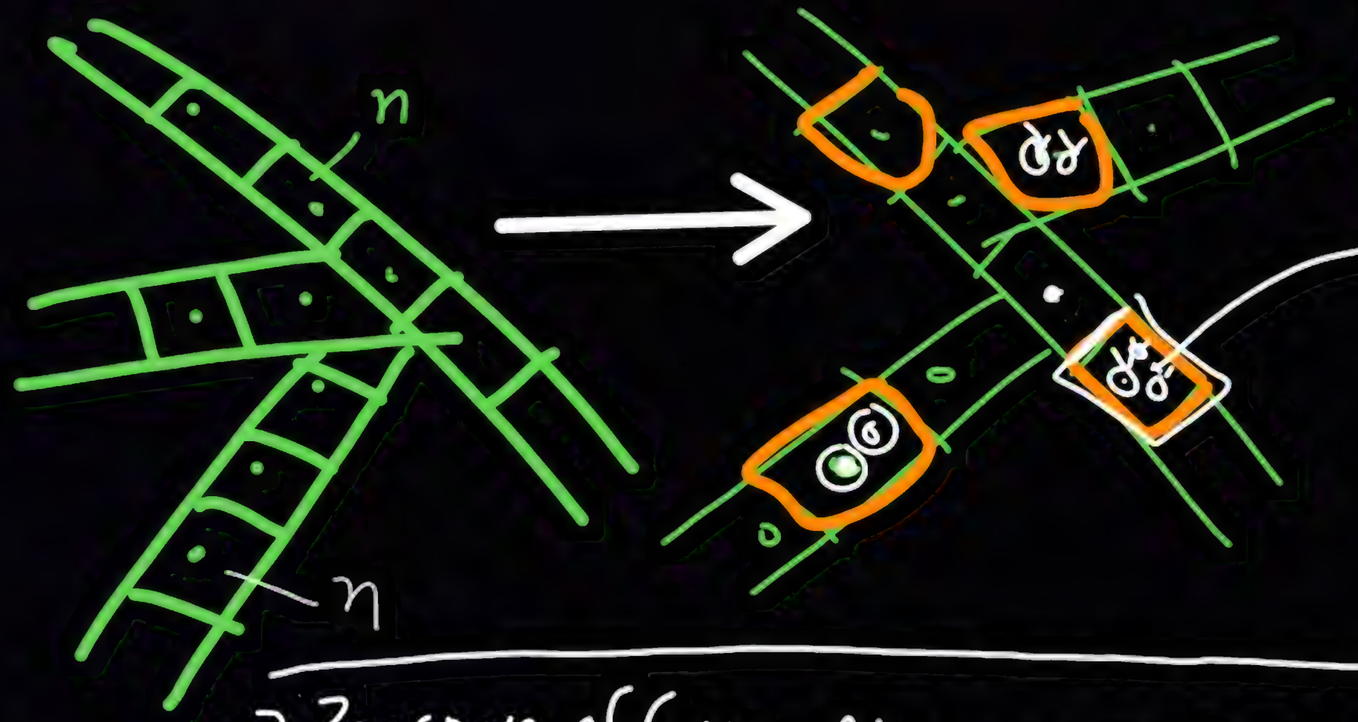

Q Zoospore present in
(a) Pinus (b) Kelp (c) Marchantia
(d) all

Zoospore
(n)
(single)

Germination
Mitosis

→ Zoospore of Green Algae - 2-8 Flagella, Equal, Apical
→ Zoospore of Brown Algae → 2 Flagella, lateral, Unequal
→ Red Algae - Zoospore Absent, Aplanospore present

note - Zoospore in Plant Kingdom only Present in Algae
Not in Bryophyte, Pteridophyte, Gymnosperm & Angiosperm

Pear Shape Zoospore (Brown Algae)

Q Fragmentation not occur in

(a) Ulothrix (b) Porphyra (c) Chlorella (d) Kelp

rule - All Algae show Fragmentation Except unicellular Algae

Q Asexual spore present in

(a) G.A (b) B.A (c) R.A (d) all

Q Zoospore present in

(a) G.A (b) B.A (c) Both a & b (d) R.A

Q Asexual spore Absent in

(a) Bryophyte
(b) Pteridophyte
(c) Gymnosperm

(d) all

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Reproduction in Algae – Sexual Reproduction in Algae

- Algae is haploid, They show true Sexual Reproduction (Form gametes & Zygote)
→ Algae produce Gametes By Mitosis (n)
→ Algae – male sex organ – Antheridium Female sex organ = Oogonium

→ **Type of Gametes**

① Isogamous → Both gamete same morphology (Genetically Different) → they can Both be motile → ♂ ♂
Both can be non-motile → ○ ○

② Anisogamous – Morphology Different → ○ ♂ or ○ ♂

③ Oogamous → Female gamete large → non-motile → Food Reserve Present → ○ (large) Female gamete
Male gamete small → Generally motile → ♂ male gamete (small)

Green Algae — Isogamous, Anisogamous, Oogamous ✓
Brown Algae → Isogamous, Anisogamous, Oogamous ✓
Red Algae → only oogamous (But male gamete is also non-motile)

(a) Isogamous → Motile → Chlamydomonas, Ulothrix, Cladophora
→ non-motile — Spirogyra

(b) Anisogamous → Eudorina

(c) Oogamous → Ex - Fucus (B.A)
- Volvox (G.A)

Q Few Ex - Fucus, Volvox, Porphyra, Eudorina, Gelidium
Ulothrix

How many oogamous
(a) three (b) four (c) Fix (d) six

Q non-motile gamete present in
(a) Kelp (b) Ulothrix
(c) Porphyra (d) Chlamydomonas

Q Isogamous non-motile
(a) Porphyra (b) Spirogyra
(c) Fucus (d) Ulothrix-mot

DOPA -

Q1 Gelidium not have Feature :- R.A
(a) Flagella (b) Chla (c) Phycoerthrin (d) all

Q2 Porphyra R.A and Ectocarpus B.A have common
(a) lateral Flagella (b) life cycle (c) Chla (d) all

Q3 Which is motile
(a) Zoospore of Kelp (b) Chlorella (c) Zoospore of Gracilaria (d) all

Q4 Filamentous branch is all Except R.A
(a) Kelp (b) Euglenoids (b) Ectocarpus (d) Cladophora
X = single cell

Q5 Few Ex- Chlamydomonas G.A, Chlorella G.A, Gracilaria R.A, Gelidium R.A, Porphyra R.A

G.A ← Chla & chlb present in
(a) three (b) Four (c) two (d) Five

Q6 Not true about Fucus (B+A)

(a) Zygotic meiosis (b) Chl a (c) Chl c (d) Algin

Q7 Haplodiplontic plant with zoospore

(a) Marchantia (b) Kelp (c) Polysiphonia (d) Chlamydomonas

Q8 Diplontic life cycle present in

(a) Spermatophyte (b) Pinus (c) Fucus (d) all

Q9 Floridean starch is similar to

(a) Amylose (b) Amylopectin (c) Starch (d) Mannitol

Q10 Wrong Match

(a) Chlorella - Chl b (b) Dictyota (B.f) - Mannitol

(c) Polysiphonia - Zygotic Meiosis (d) Porphyra (R+) - Aplanospore

C

Importance of Algae

① Algae is producer in Oceans (More than 50% CO_2 Fix)

② Algae (Oxygenic photosynthesis) ⟶ Increase O_2 level in Surrounding

③ Algae come First in Food chain (Aquatic Ecosystem)

④ 70 marine species of Algae – which is Edible
Porphyra, Laminaria, Sargassum

⑤ Brown Algae – cell wall – Algin
Red Algae – cell wall – Carrageen } – water hold
So called Hydrocolloid (Phycocolloid)

laminaria

(6) Red Algae ⟶ Gelidium, Gracilaria } ⟶ Chemical obtain Agar-Agar → (जमा देता है) Sodify

Use in Culture of Microbe

Jellies & ice cream

Medium + Agar

(7) Chlorella – Green Algae (tablets)

(Source of Protein)

↳ Use By Space traveller – As a source of Food

Algae are useful to man in a variety of ways. At least a half of the total carbon dioxide fixation on earth is carried out by algae through photosynthesis. Being photosynthetic they increase the level of dissolved oxygen in their immediate environment. They are of paramount importance as primary producers of energy-rich compounds which form the basis of the food cycles of all aquatic animals. Many species of *Porphyra*, *Laminaria* and *Sargassum* are among the 70 species of marine algae used as food. Certain marine brown and red algae produce large amounts of hydrocolloids (water holding substances), e.g. **algin** (brown algae) and **carrageen** (red algae) which are used commercially. Agar, one of the commercial products obtained from *Gelidium* and *Gracilaria* are used to grow microbes and in preparations of ice-creams and jellies. *Chlorella* a unicellular alga rich in proteins is used as food supplement even by space travellers. The algae are divided into three main classes: **Chlorophyceae, Phaeophyceae** and **Rhodophyceae**.

Classification of Algae

Algae Divided into three Classes

(a) Green Algae – Chlorophyceae
(b) Brown Algae – Phaeophyceae
(c) Red Algae – Rhodophyceae

	Chlorophyceae	Phaeophyceae	Rhodophyceae
Habitat	Fresh water mainly But Marine also (Few)	Marine	Marine – deep sea, Warm water
Structure	Unicellular – Chlamydomonas (motile), Chlorella (non-motile) Colonial – Volvox Filamentous – Ulothrix, Cladophora, Spirogyra (Branch) → Chara → (Branch Filamentous) (Female sex organ) Oogonium (Upper) Antheridium (male sex organ) – Chara (sex organ)	– Multicellular Filamentous Branch Branch Simple Branch Ex – Ectocarpus Profusely Branch Ex – More Branch Kelp (Grow 100 m)	→ Multicellular Filamentous Branch – Frond & Hold Fast Present → Brown Algae – thallus three part ① Frond – main Photosynthetic Air Bladder stipe Hold Fast (Attachment)

	Chlorophyceae	Phaeophyceae	Rhodophyceae
- Cell wall	Cellulose + Pectin	Cellulose + Algin	Cellulose + Carageen Polysulphate Ester
- Flagella	2-8 Apical Equal	2, lateral Unequal	Absent
- Pigment	Chla & chlb - Different shape of Chloroplast - Cup shape Spiral, Reticulate Ribbon shape - Inside chloroplast Pyrenoid present (store protein beside starch)	Chla & chlc, Fucoxanthin Olive Green to Brown Colour with the Amount of Fucoxanthin type of Xanthophyll	Chla & chld γ - Phycoerythrin (Red pigment)
Storage	starch + oil	Laminarian starch Mannitol	Floridian Starch Similar to Amylopectin & Glycogen

	Chlorophyceae	Phaeophyceae	Rhodophyceae
Reproduction			
Asexual Reproduction	Fragmentation — Zoospore (2-8 Flagella, Apical)	Fragmentation — Zoospore (2, lateral, Unequal)	Fragmentation — Aplanospore (non-motile spore)
Sexual Reproduction	— Isogamous → Spirogyra – non motile Cladophora, Ulothrix – motile — Anisogamous – Eudorina — Oogamous – Volvox	— Isogamous — Anisogamous — Oogamous – Fucus	all Red Algae Oogamous – Complex post Fertilization Changes (also – male gamete – non-motile)
Sex organ	— Oogonium → Female gamete (Egg) – gamete	– Brown Algae Oogonium & Antheridium present	
Male sex organ – Antheridium	Gamete (motile) – Antherozooid → gamete	– male gamete → (Antherozooid) Pear shape	

♀ Antherozooid (male gamete) — single cell haploid
Flagella

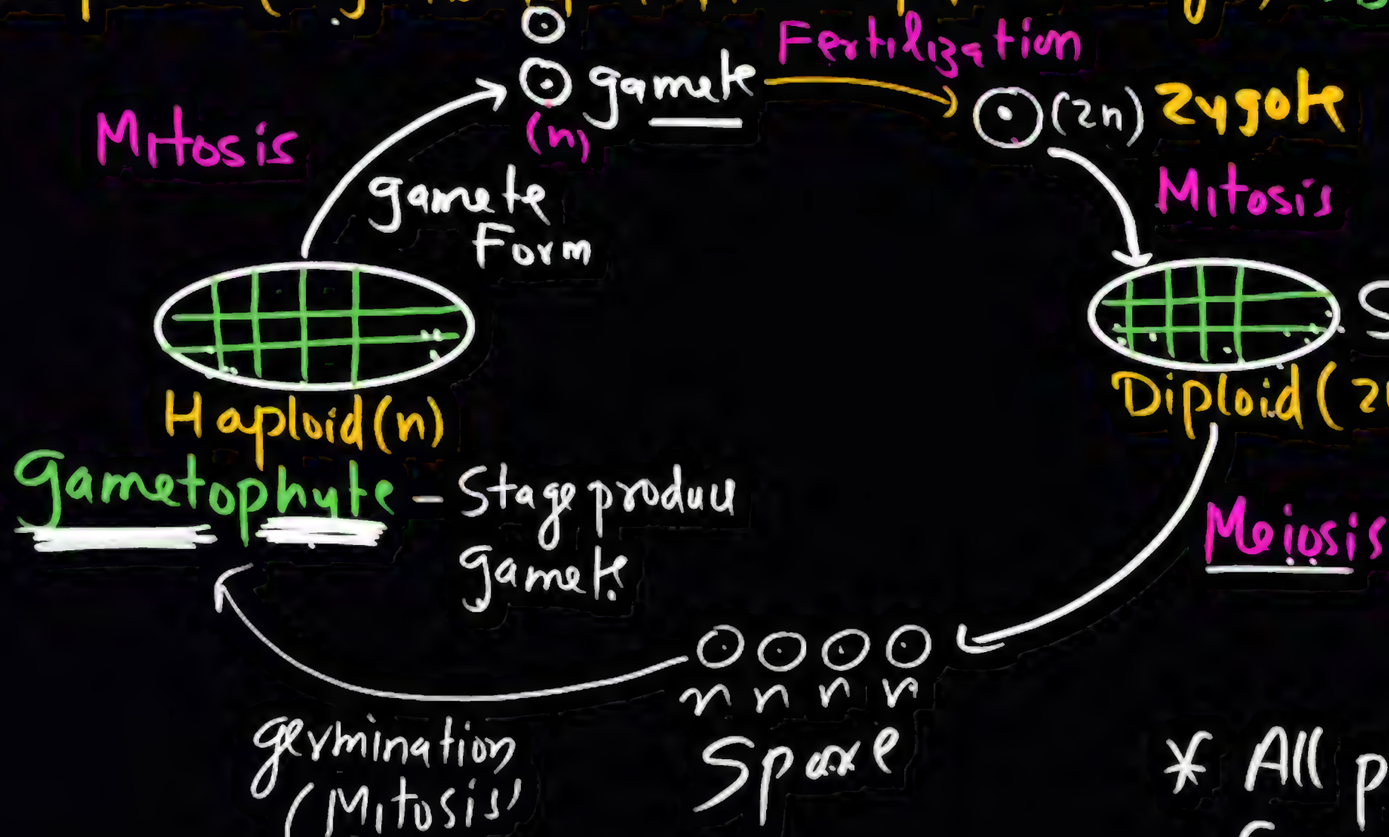
Sex organ in Algae

(a) Oogonium – Female sex organ
– haploid, multicellular
] – Produce Egg(n), single cell, no Flagella

(b) Antheridium → Male sex organ → Produce male gamete → ♂ Antherozooid
– haploid, Multicellular

Sexual Reproduction in plant Kingdom

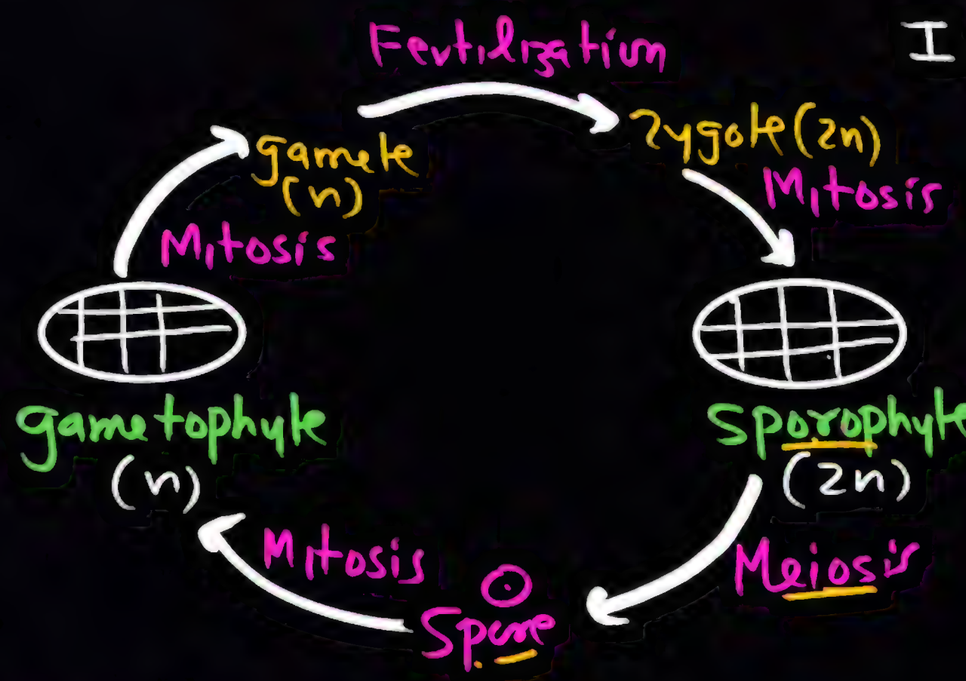
- All plants (Algae, Bryophyte, Pteridop, Gymno & Angio) → Both haploid & Diploid phase present — Life cycle



* Gametophyte stage produce Gametes, it is haploid & Multicellular

* Sporophyte stage - Diploid & Multicellular & Produce Spore By Meiosis

* All plants have Both these stages Sporophyte & Gametophyte



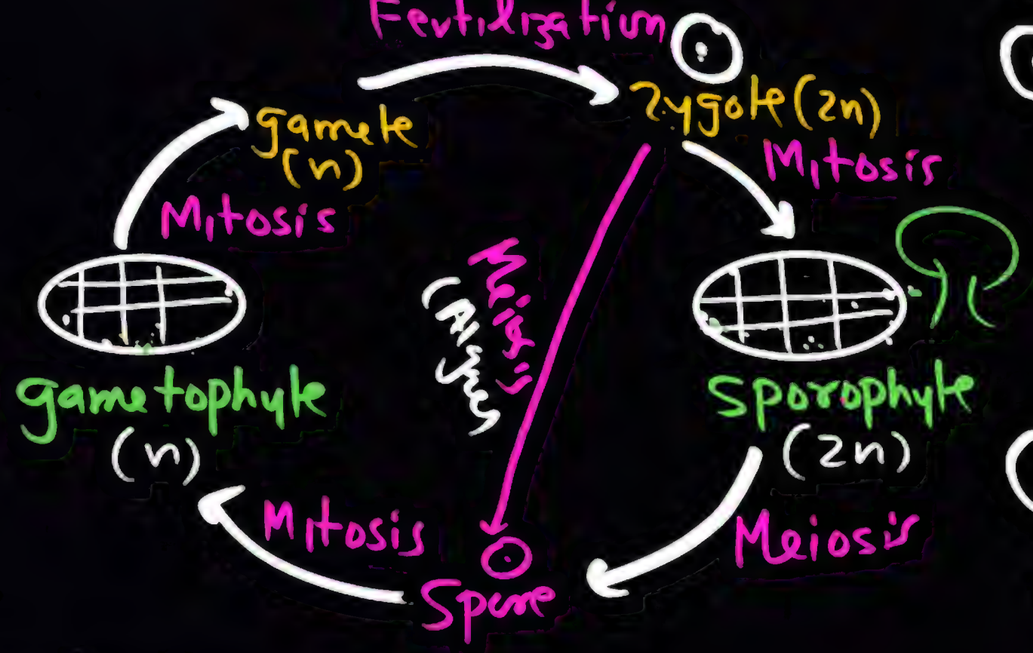
I **Haploid plants** – Gametophyte stage is main plant, Dominant (Green, photosynthetic)
Ex – Algae, Bryophyte

II **Diploid plants** – Sporophyte stage Green, photosynthetic Dominant (For more time)
Ex – Pteridophyte, Gymnosperm, Angiosperm

Q Which is haploid plant
(a) Equisetum (b) Pinus (c) Marchantia (d) NEEM
Pte (Gymno) (Bryo) (Ang)

Q Gametophyte stage is Dominant main plant Body
(a) Sphagnum (b) Cycas (c) Rose (d) Pteris
Bry Gy An Pt

Q Sporophyte is Green photosynthetic, main plant Body in
(a) Cladophora (b) Selaginella
Alg Pt
(c) Funaria (d) Chlamydomonas
Bry Alg



Life cycle :-

⊙ Haplontic life cycle → Algae
→ Zygotic meiosis occur

(Diploid stage is Reduced → very less cell
Zygote undergo mitosis

⊙ Diplontic life cycle (Gymno, Angio)
- Very less cells in gametophyte
Ex - Pollen Grain - only 3 cells)

⊙ Haplodiplontic
- gametophyte & sporophyte - Both have Sufficient no of cells

Ex - Bryophyte - main stage - gametophyte
- Pteridophyte - main stage - sporophyte (2n)
(Diploid

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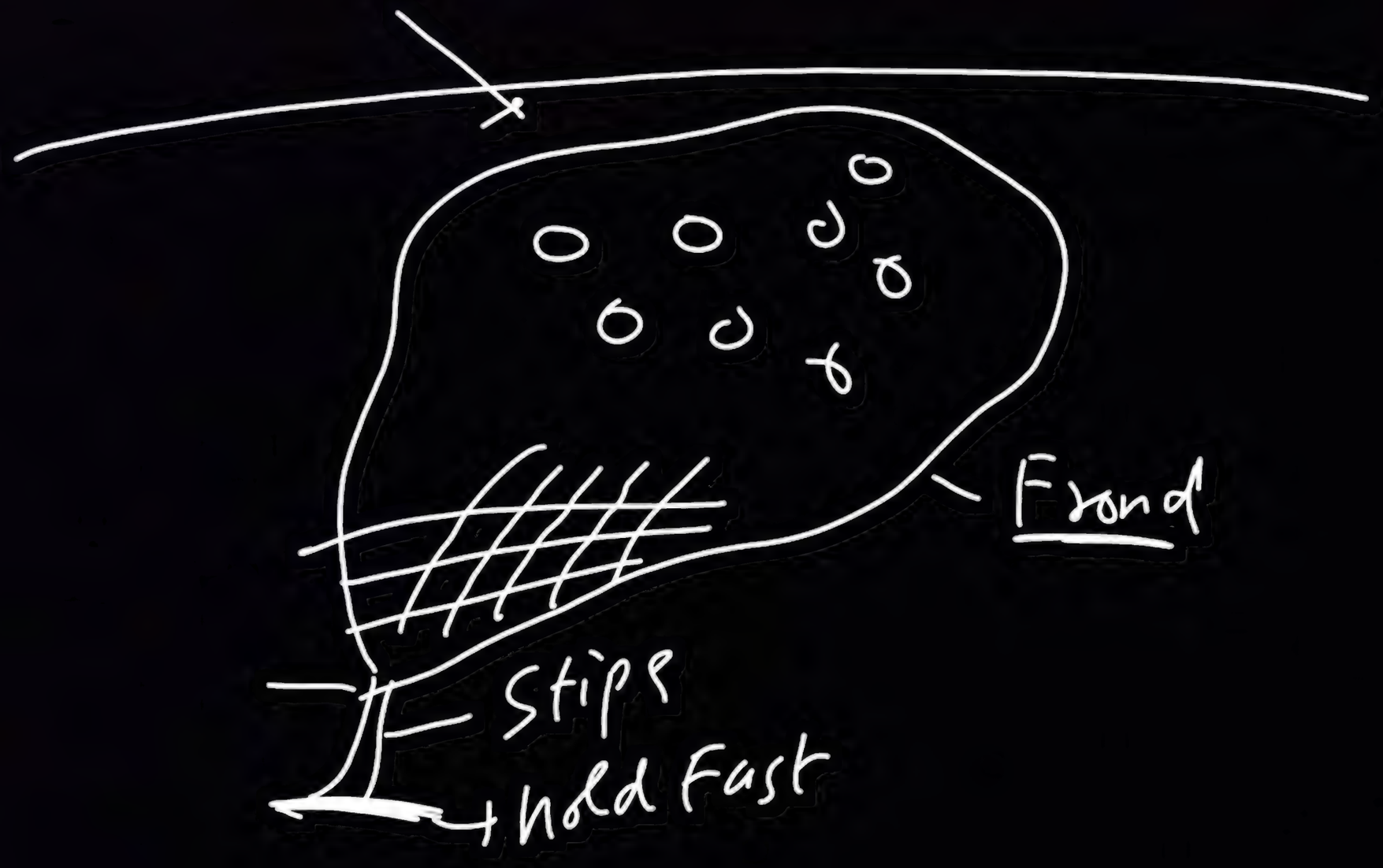
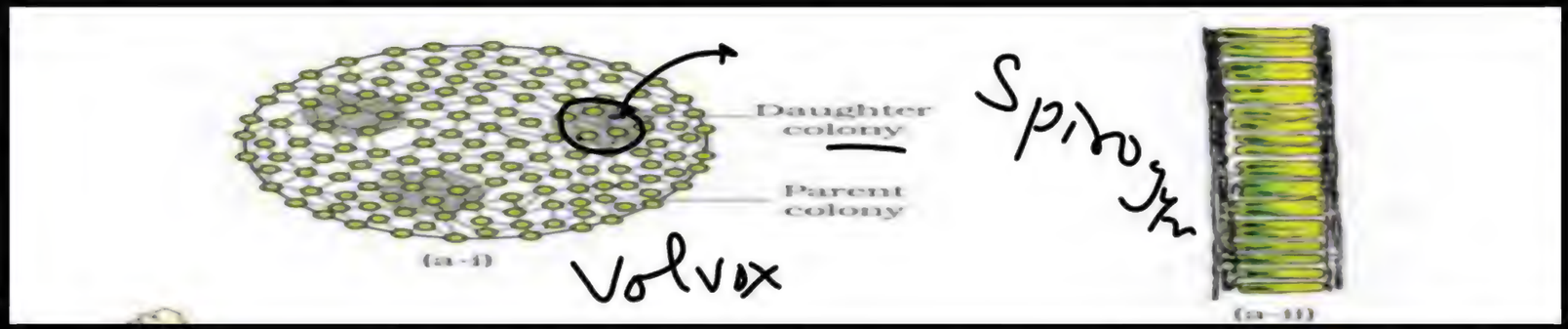
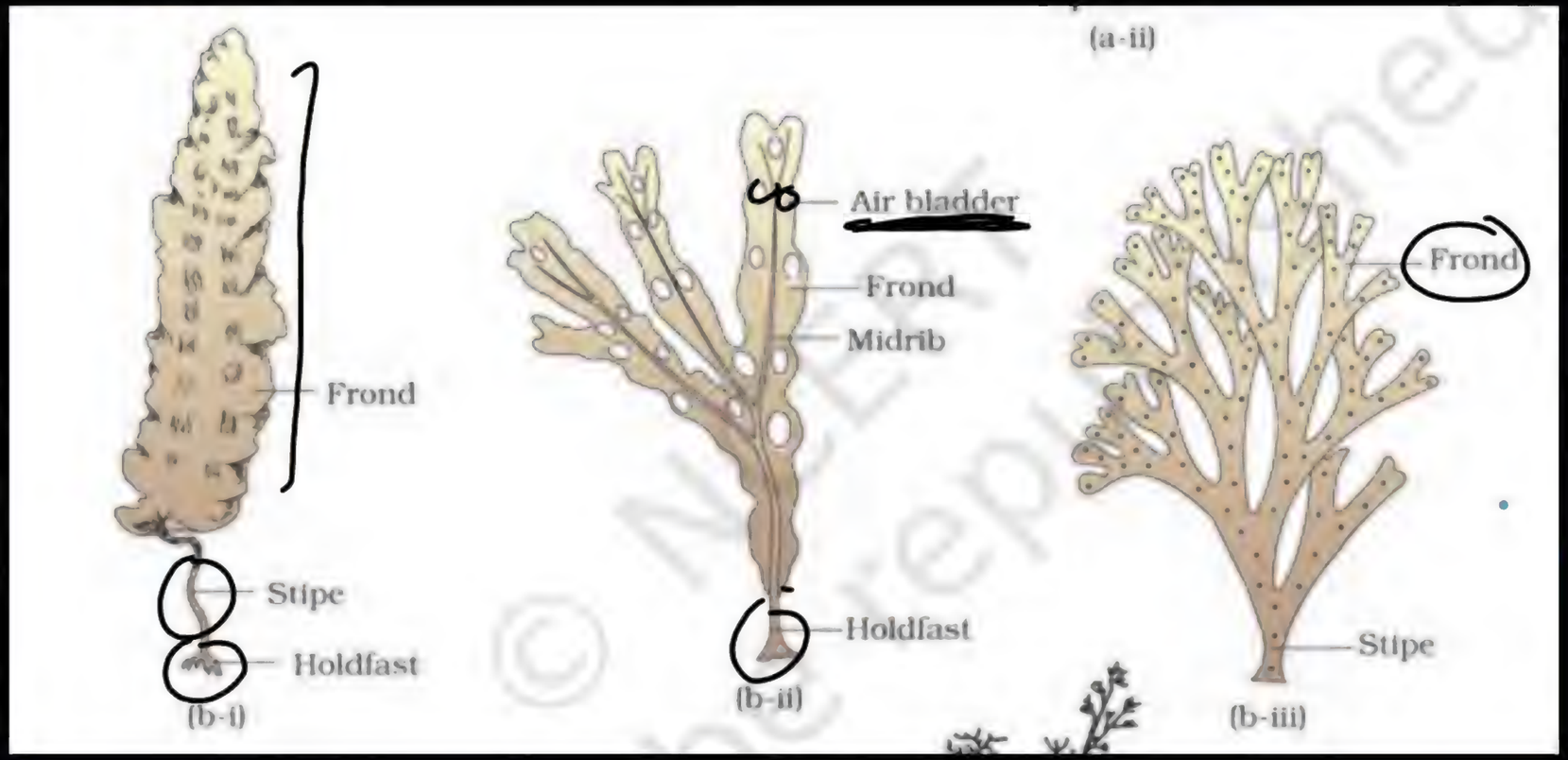
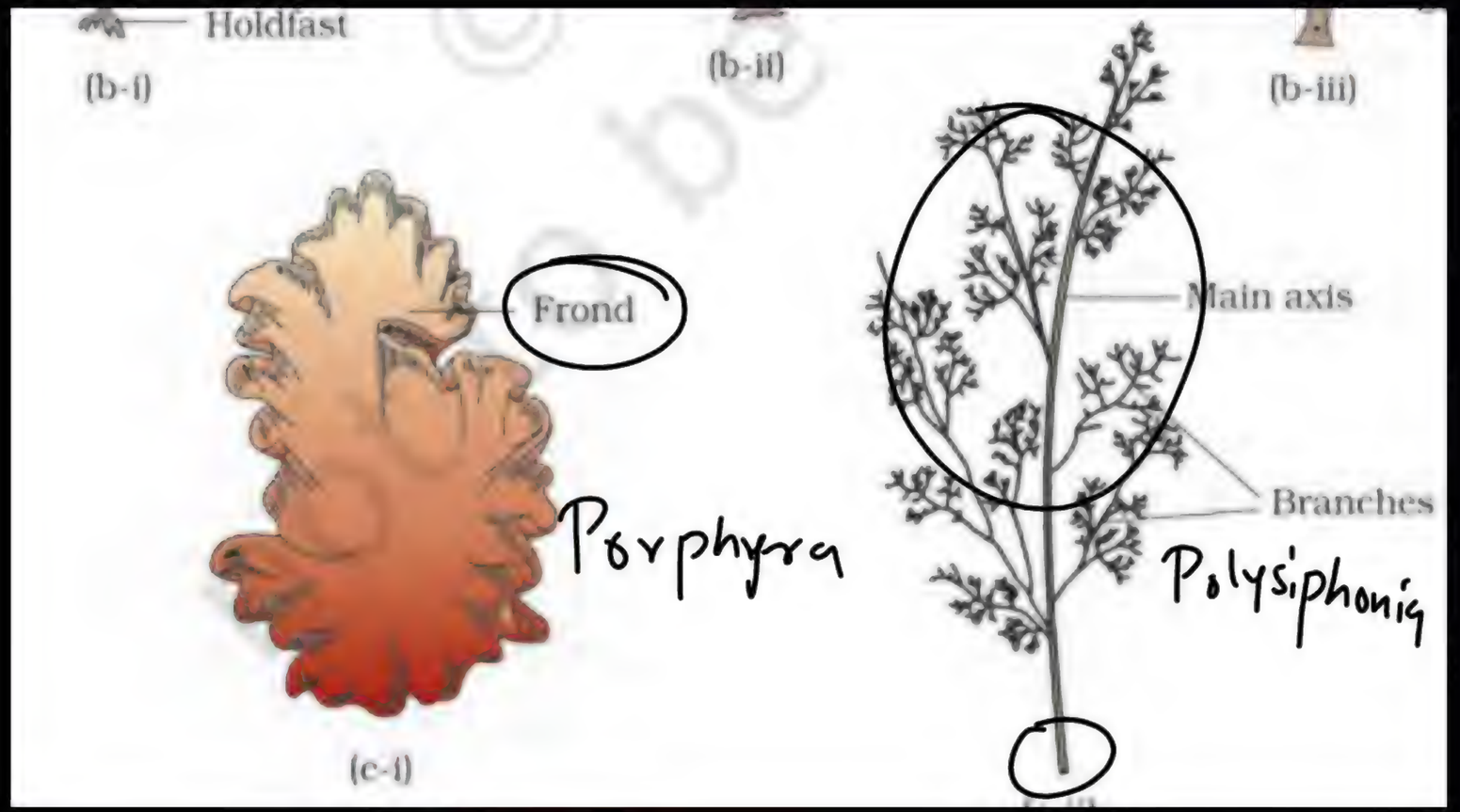

Frond
Stipe
Hold Fast


Daughter colony
Parent colony
(a-i)
Volvox
Spirogyra
(a-ii)


Frond
Stipe
Holdfast
(b-i)
Air bladder
Frond
Midrib
Holdfast
(b-ii)
Frond
Stipe
(b-iii)


Holdfast
(b-i)
(b-ii)
(b-iii)
Frond
Porphyra
(c-i)
Main axis
Branches
Polysiphonia

3.1.2 Phaeophyceae

The members of phaeophyceae or **brown algae** are found primarily in marine habitats. They show great variation in size and form. They range from simple branched filamentous forms (*Ectocarpus*) to profusely branched forms as represented by kelps, which may reach a height of 100 metres. They possess chlorophyll *a*, *c*, carotenoids and xanthophylls. They vary in colour from olive green to various shades of brown depending upon the amount of the xanthophyll pigment, fucoxanthin present in

Chlorophyceae Phaeophyceae Rhodophyceae

cell theory

cell theory

3.1 Algae

Algae are chlorophyll-bearing, simple, thalloid, autotrophic and largely aquatic (both fresh water and marine) organisms. They occur in a variety of other habitats: moist stones, soils and wood. Some of them also occur in association with fungi (lichen) and animals (e.g., on sloth bear).

The form and size of algae is highly variable, ranging from colonial forms like *Volvox* and the filamentous forms like *Ulothrix* and *Spirogyra* (Figure 3.1). A few of the marine forms such as kelps, form massive plant bodies.

The algae reproduce by vegetative, asexual and sexual methods. Vegetative reproduction is by fragmentation. Each fragment develops into a thallus. Asexual reproduction is by the production of different types of spores, the most common being the **zoospores**. They are flagellated (motile) and on germination gives rise to new plants. Sexual reproduction takes place through fusion of two gametes. These gametes can be flagellated and similar in size (as in *Ulothrix*) or non-flagellated (non-motile) but similar in size (as in *Spirogyra*). Such reproduction is called **isogamous**. Fusion of two gametes dissimilar in size, as in species of *Eudorina* is termed as **anisogamous**. Fusion between one large, non-motile (static) female gamete and a smaller, motile male gamete is termed **oogamous**, e.g., *Volvox*, *Fucus*.

3.1.1 Chlorophyceae

The members of chlorophyceae are commonly called **green algae**. The plant body may be unicellular, colonial or filamentous. They are usually grass green due to the dominance of pigments chlorophyll *a* and *b*. The pigments are localised in definite chloroplasts. The chloroplasts may be discoid, plate-like, reticulate, cup-shaped, spiral or ribbon-shaped in different species. Most of the members have one or more storage bodies called pyrenoids located in the chloroplasts. Pyrenoids contain protein besides starch. Some algae may store food in the form of oil droplets. Green algae usually have a rigid cell wall made of an inner layer of cellulose and an outer layer of pectose.

Vegetative reproduction usually takes place by fragmentation or by formation of different types of spores. Asexual reproduction is by flagellated zoospores produced in zoosporangia. The sexual reproduction shows considerable variation in the type and formation of sex cells and it may be isogamous, anisogamous or oogamous. Some commonly found green algae are: *Chlamydomonas*, *Volvox*, *Ulothrix*, *Spirogyra* and *Chara* (Figure 3.1a).

cell theory

cell theory

them. Food is stored as complex carbohydrates, which may be in the form of laminarin or mannitol. The vegetative cells have a cellulosic wall usually covered on the outside by a gelatinous coating of **algin**. The protoplast contains, in addition to plastids, a centrally located vacuole and nucleus. The plant body is usually attached to the substratum by a **holdfast**, and has a stalk, the **stipe** and leaf like photosynthetic organ – the **frond**. Vegetative reproduction takes place by fragmentation. Asexual reproduction in most brown algae is by biflagellate zoospores that are pear-shaped and have two unequal laterally attached flagella.

Sexual reproduction may be isogamous, anisogamous or oogamous. Union of gametes may take place in water or within the oogonium (oogamous species). The gametes are pyriform (pear-shaped) and bear two laterally attached flagella. The common forms are *Ectocarpus*, *Dictyota*, *Laminaria*, *Sargassum* and *Fucus* (Figure 3.1b).

cell theory

3.1.3 Rhodophyceae

The members of rhodophyceae are commonly called **red algae** because of the predominance of the red pigment, r-phycoerythrin in their body. Majority of the red algae are marine with greater concentrations found in the warmer areas. They occur in both well-lighted regions close to the surface of water and also at great depths in oceans where relatively little light penetrates.

The red thalli of most of the red algae are multicellular. Some of them have complex body organisation. The food is stored as floridean starch which is very similar to amylopectin and glycogen in structure.

The red algae usually reproduce vegetatively by fragmentation. They reproduce asexually by non-motile spores and sexually by non-motile gametes. Sexual reproduction is oogamous and accompanied by complex post fertilisation developments. The common members are: *Polysiphonia*, *Porphyra* (Figure 3.1c), *Gracilaria* and *Gelidium*.

Cell Theory

cell theory

MANTHAN NEET 2025 -

Plant kingdom

lecture - 4

Botany

TARUN SIR

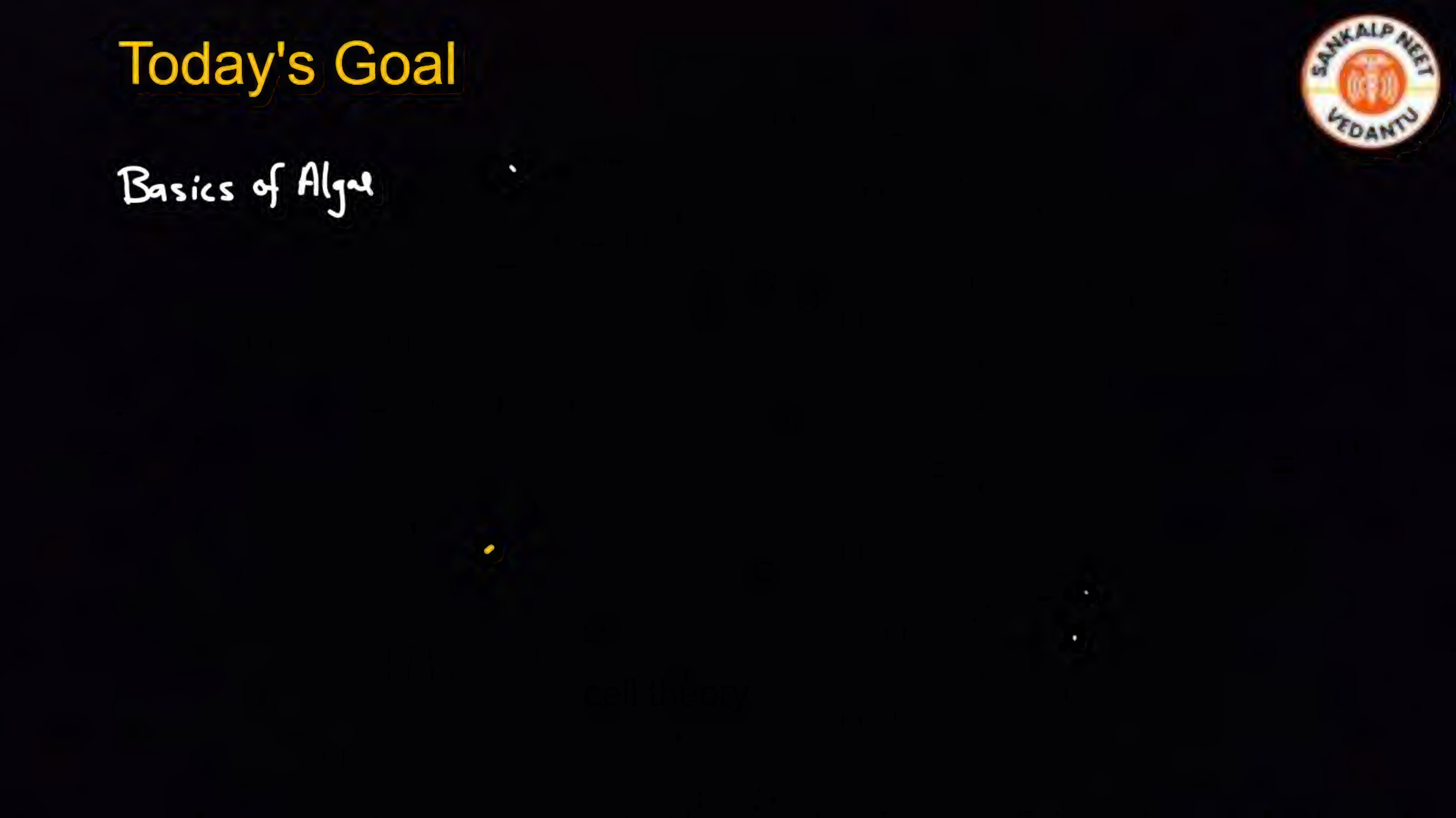
Topics

- Algae
- Bryophyte
- pteridophyte
- Gymnosperm
- Angiosperm

2 no of Question + 3 → 12 Marks

Today's Goal

Basics of Algae



Important Examples

Green Algae — Chlamydomonas, Chlorella, Spirogyra, ulothrix, Chara, Cladophora, Voluox, Eudorina

Brown Algae – Ectocarpus, Kelp, Laminaria, Sargassum, Fucus, Dictyota

Red Algae — Polysiphonia, Gelidium, Gracilaria, Porphyra

Phycoerythrin – (Red Algae)

Q1 Phycoerythrin present in
(a) Voluox (b) Ulothrix (c) Fucus (d) Gelidium

cell theory

II

Bryophytes

- Liverworts → Marchantia ←
- Moss → Sphagnum, Polytrichum, Funaria

III

Pteridophytes

Fern

1. Psilopsida → - Psilotum ✓
2. Pteropsida - Pteris, Dryopteris, Adiantum, Azolla, Salvinia
3. Sphenopsida - Equisetum (Horse tail)
4. Lycopsida - Selaginella, Lycopodium

IV

Gymnosperm →

Conifers - Pinus, Cedrus
- Cycas
- Sequoia, Ginkgo
(tallest tree)

Q Which is Pteridophyte

(a) Ginkgo (b) Salvinia (c) Sphagnum (d) Fucus

Q2 Few Ex. are given

Fucus (B.A), Funaria (Br), Sphagnum (Br), Selaginella (Pt), Sequoia (Gy), Porphyra (R.A), Pinus (Gym)

Chlorella (G.A), Cycas (Gym), Equisetum (Pt), Ginkgo (Gym)

- Ptérido 2
- Gymno – 4
- Bryo – 2
- Algae – 3

G.A → 1

B.A – 1

R.A – 1

cell theory

Q Few Ex are given

Polysiphonia (R.A), Psilotum (Pt), Pteris (Pt), Funaria (Bry), Dictyota (B.A), Laminaria (B.A)

Volvox (G.A), Sequoia (Gym), Pinus (Gym), Neem (Ang), Rose (Ang), Gelidium (R.A), Lycopodium (Pt)

Algae - 5

Bryo - 1

Pte - 3

Gym - 2

Ang - 2

G.A - 1

B.A 2

R.A - 2

cell theory

Algae

Topics need to study

1. Habitat
2. Structure ✓
3. Nutrition → not study in detail – Oxygenic photosynthesis (Entire plant Kingdom Show only this)
4. Reproduction
5. Importance ←
6. Classification of Algae
   - Chlorophyceae – Green Algae
   - Phaeophyceae – Brown Algae
   - Rhodophyceae – Red Algae

cell theory

Basics of Algae

[Alga - Single
Algae - Plural]

① It is chlorophyll bearing = Photosynthetic

② Eukaryotic, mostly multicellular Algae (Few Unicellular Algae Chlamydomonas, Chlorella)

③ thalloid → no proper shape

→ no proper Root, stem, & leaf] Shape → thallus like

④ Mostly Aquatic]

cell theory

Habitat

- Most Aquatic
  - Fresh water
    - Stagnant (Pond water)
    - Flowing (River)
  - Marine (Flowing) (deep sea, Brackish water, warm water)

Some Algae Also Found ⟶ ① Brackish water (Fresh mix with marine)

② Moist stone ③ on wood (moist) ④ Snow

⑤ deep sea (Problem - Light less)

(6) On sloth bear - (Grow on Animals)

⑦ In lichen

Green Algae - Mostly Fresh water

Brown Algae - Marine

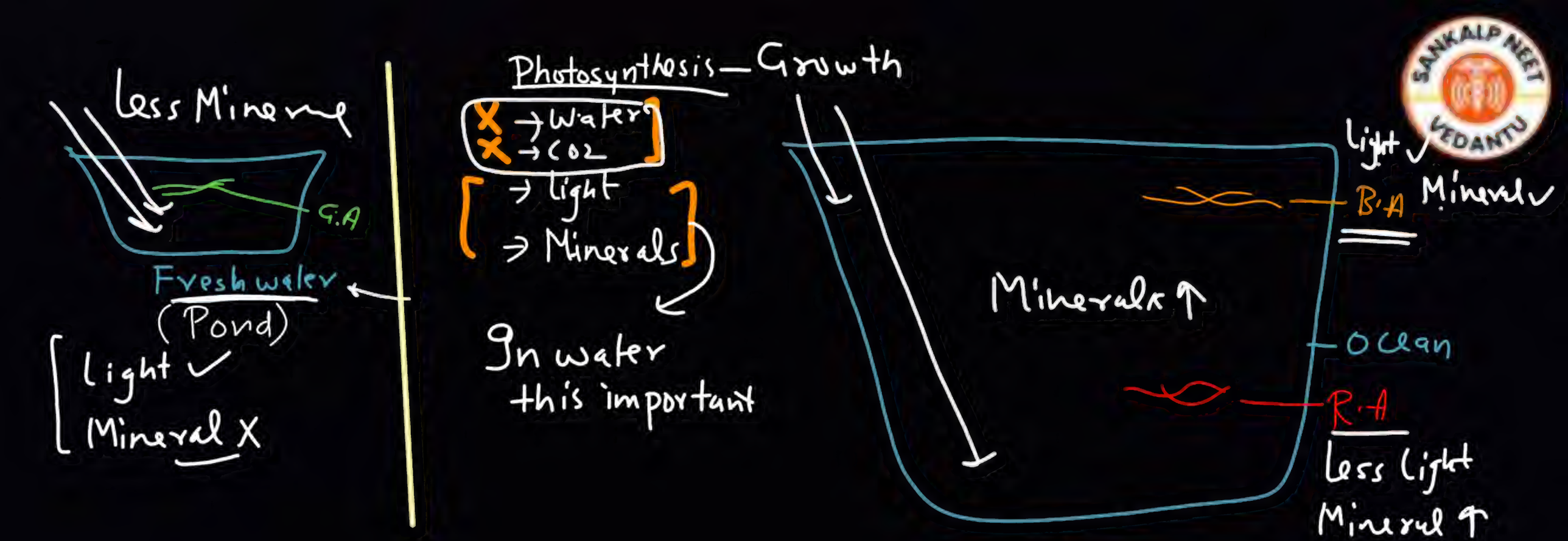
Red Algae - Mostly Marine → deep sea, Warm water

Q1 Which Algae Grow in maximum size

(a) Green Algae (b) Brown Algae

(c) Red Algae (d) all

cell theory


less Mineral
G.A
Fresh water
(Pond)
light ✓
Mineral X
Photosynthesis → Growth
→ water
→ CO2
→ light
→ Minerals
In water
this important
light ✓
B.A
Mineral ✓
Minerals ↑
Ocean
R.A
less light
Mineral ↑

cell theory

Structure of Algae

→ Algae is thalloid

→ Two topic study – ① External structure ② Cell detail →

External structure – Algae show Range/variable Form & Size

Different Form of Algae – Different shape

(a) Unicellular Algae → only Example in Green Algae →

Chlamydomonas (motile)
Chlorella (non-motile)

(b) Colonial Algae →

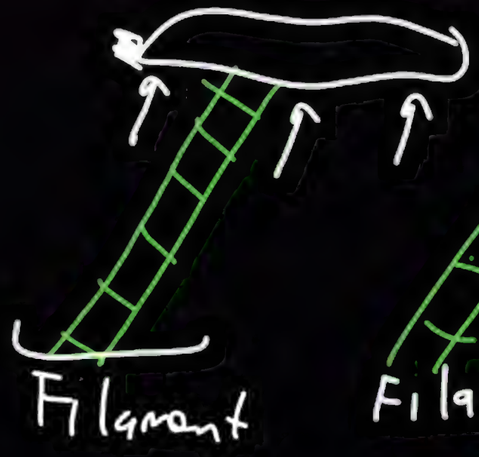
Example – Voluox

(c) Filamentous (most common) →

Filament →
- → Unbranch → Ex- Spirogyra, Ulothrix
- → Branch – Ex- Cladophora

→ Brown Algae → maximum Size
→ Red Algae

Q Colonial Algae is
(a) Voluox (b) Chlamydomonas (c) Spirogyra
(d) Fucus



Q1 Algae which show maximum Form

(a) G:A (b) B:A (c) R:A (d) none

Q2 Most common Form in Algae

(a) Unicellular (b) Filamentous unbranch

(c) Filamentous Branch (d) colonial

Note – Brown Algae can grow upto 100 meter or more

cell theory

Holdfast
(Attachment

Q Hold Fast Absent in
(a) Fucus (b) Kelp.
(c) Spirogyra (d) Gelidium
(Pond)

cell theory

Detail of Algae cell

(Algae cell Eukaryotic
well defined nucleus, Membrane bound organelle)

—only study → cell wall, Pigment, Flagella, Storage

Cell wall → Rigid structure, main component cellulose

Green Algae → Inner cellulose outer pectin
(Rigid)

Brown Algae → Cellulose + Algin

Red Algae → Cellulose + Carageen
(Polysulfate Ester)

Algae cell wall
— Cellulose

Q Carageen present in (R·A)
(a) Volvox (G·A) (b) Gelidium (R·A) (c) Kelp (B·A)
(d) Fucus (B·A)

Q Alginic Acid present in
(a) Chlorella (G·A) (b) Porphyra (R·A) (c) Dictyota (B·A) (d) Ulothrix (G·A)

cell theory

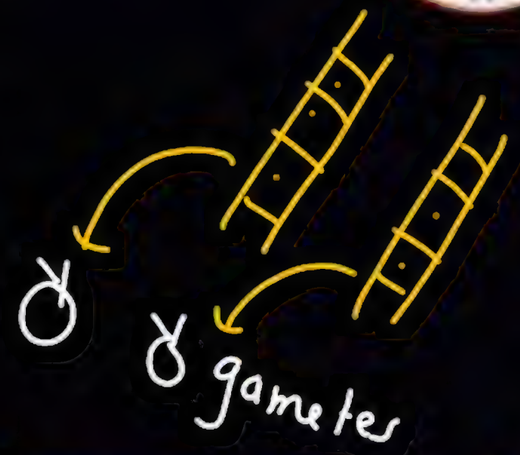
Flagella

Algae Aquatic → normally have Flagella (9+2) type)

- Algae Flagella present in (a) Asexual spore (b) Gametes

Zoospore (Asexual spore)

Flagella = Motile



Green Algae → 2-8 Flagella → Apical, Equal – [Exception – Spirogyra – non-motile

Brown Algae → 2 Flagella, Unequal, lateral →

Red Algae – no Flagella (not in gametes, not in Asexual spore (non-motile, Aplanospore)

cell theory

Q Few Example – Kelp (B.A), Ectocarpus (B.A), Ulothrix (G.A), Porphyra (R.A), Gelidium (R.A), Chlamydomonas (G.A)

How many have → (a) Algin – 2 (b) Apical Flagella – 2 (c) Motile (Zoospore) (G.A + B.A) = 4 (d) Gametangium = R.A = 2

Q1 Zoospore Absent in

(a) Albugo (Phyco) (b) Ulothrix (G.A) (c) Chlamydomonas (G.A) ~~(d) Porphyra (R.A)~~

2 2 4 2

Q2 Aplanospore is present in ——

(a) Aspergillus (b) Polysiphonia (c) Claviceps ~~(d) all~~

R.A = non-motile

Conidia = non-mt

SANKALP NEET VEDANTU

cell theory

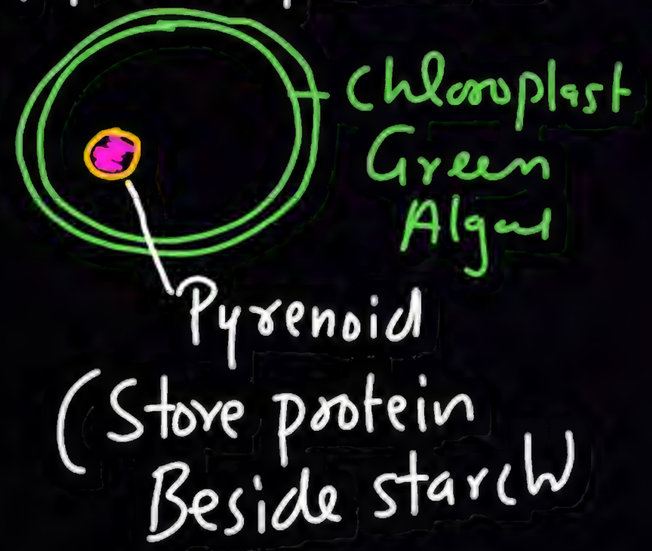
Pigments

- Algae have plastids → which have pigments
- All Algae have Chl a (O2 produce → Oxygenic)
- Green Algae – Different shape → chloroplast (Cup shape, spiral, Reticulate, Disc)

Green Algae → Chl a + Chlorophyll b — note → Inside chloroplast of Green Algae Pyrenoid present

Brown Algae → Chl a + Chl c + Fucoxanthin – Brown (type of Xanthophyll)

Red Algae → Chl a + Chl d + Phycoerythrin (Red Colour)



Q Fucoxanthin pigment present in
(a) Volvox (b) Dictyota (c) Porphyra (d) Ulothrix

Q Carageen containing Algae not have
(a) Well defined nucleus (b) Chlorophyll (c) Flagella (d) Cell wall

storage → All Algae Synthesis Food in Form of Glucose But storage Form Different

Green Algae – Store starch (mainly) + oil

Brown Algae – laminarian starch and Mannitol (derive From Mannose)

Red Algae – Floridean starch (Structure Similar to Glycogen & Amylopectin)

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Q Few Example are Given :- Cladophora (G·A), laminaria (B·A), Gelidium (R·A), Ectocarpus (B·A), Fucus (B·A), Gracilaria (R·A), Volvox (G·A), Ulothrix (G·A), Kelp (B·A)

How many have

(a) Carageen – R·A = 2

(b) Pyrenoid – G·A = 3

(c) laminarian starch = 4 B·A

(d) Zoospore – G·A + B·A = 7

(e) Zoospore with lateral Flagella = 4 B·A

(f) Aplanospore = R·A = 2

(g) non-motile Gamete = R·A = 2

Q Few Ex are given

Sargassum (B.A), Endoring (G.A), Gracilaria (R.A), Porphyra (R.A), Ulothrix (G.A)

Polysiphonia (R.A), Cladophora (G.A), Fucus (B.A), Voluox (G.A), Chlamydomonas (G.A)

How many show

(1) – Floridean starch – 3

(2) Carageen – 3 R.A

(3) laminarian starch – 2

(4) Motile gamete – G.A + B.A = 7

(5) lateral Flagella = 2

(6) Algin = 2

(7) Non-motile gamete = 3

G.A → 5 R.A = 3

B.A = 2 =

3327223

cell theory

Q Floridean starch present in

(a) Ulothrix (2) Kelp (b) Porphyra (d) Agaricus

Q Chl c present in

(a) Equal Flagell Algae — B·A

(b) Algae with Floridean starch — R·A

(c) Algae with No Flagella — R·A

(d) Algae with mannitol

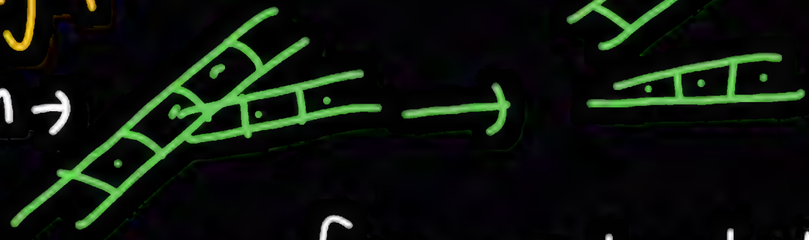
cell theory

Reproduction in Algae

Algae is lower organism, Show Both Asexual & Sexual (Favorable Asexual Reproduction)

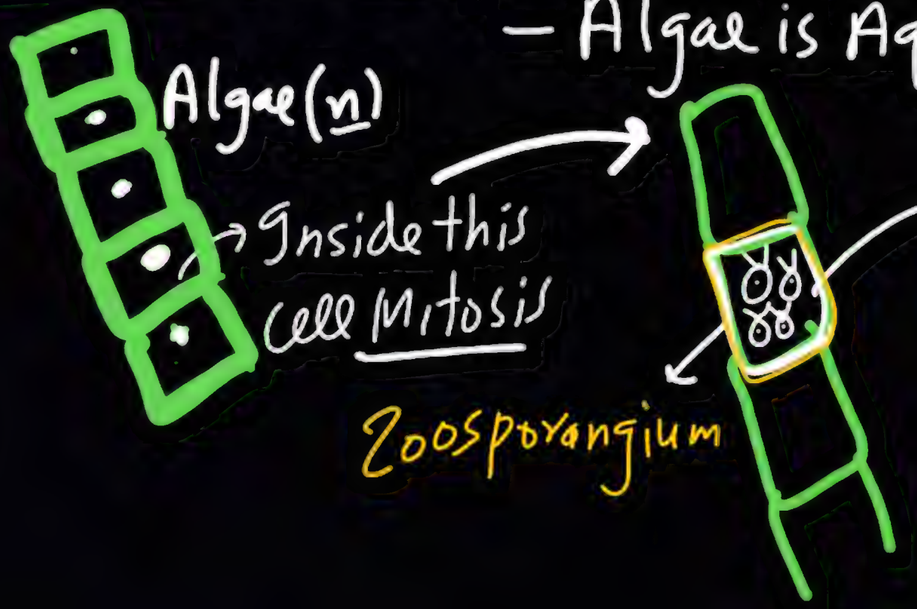
Type of Reproduction in Algae

I Vegetative → Fragmentation →



II Asexual Reproductim → Spore Formation (Algae is haploid – spore produce By Mitosis)

– Algae is Aquatic → main spore is Zoospore (Except Red Algae Aplanospore)



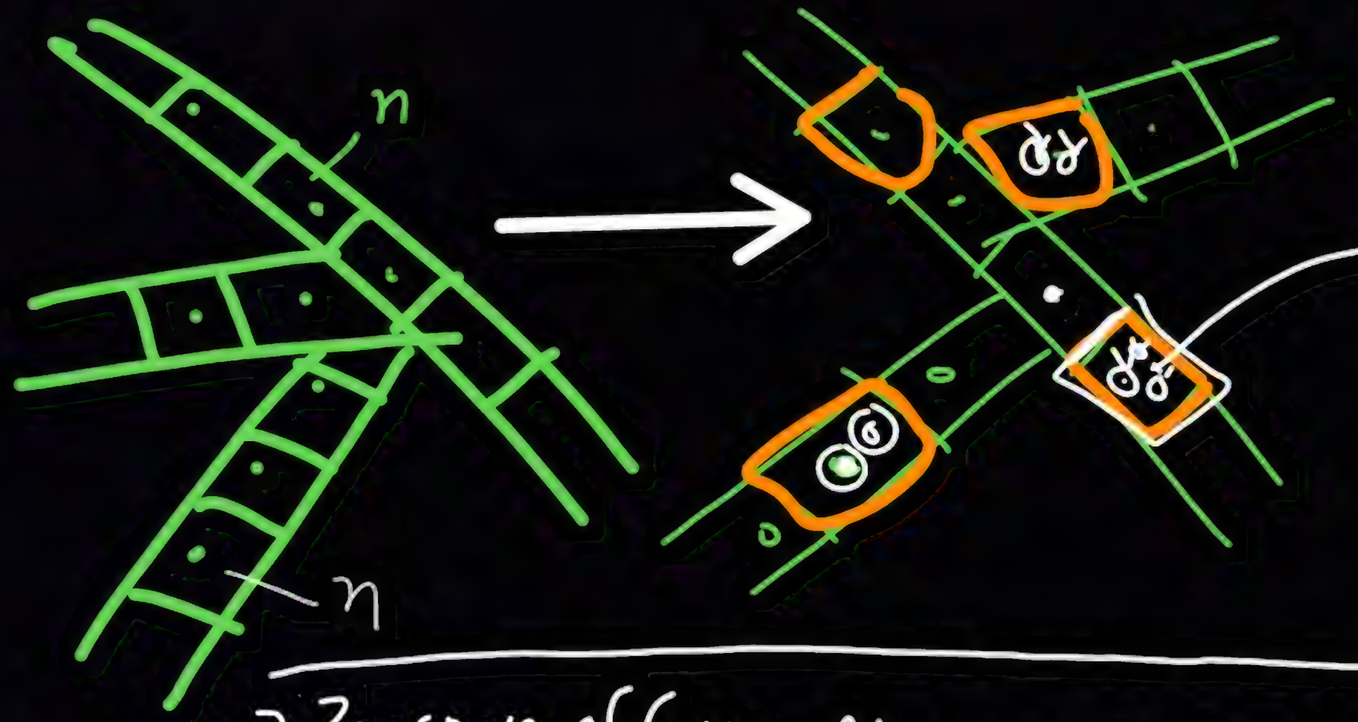
Mitosis

Zoospore (n) (motile)

B →

Filament

cell theory



Q Zoospore present in
(a) Pinus (b) Kelp (c) Marchantia
(d) all

Zoospore
(n)
(single)

Germination
Mitosis

→ Zoospore of Green Algae - 2-8 Flagella, Equal, Apical
→ Zoospore of Brown Algae → 2 Flagella, lateral, Unequal
→ Red Algae - Zoospore Absent, Aplanospore present

note - Zoospore in Plant Kingdom only Present in Algae
Not in Bryophyte, Pteridophyte, Gymnosperm & Angiosperm

Pear Shape Zoospore (Brown Algae)

Q Fragmentation not occur in

(a) Ulothrix (b) Porphyra (c) Chlorella (d) Kelp

rule - All Algae show Fragmentation Except unicellular Algae

Q Asexual spore present in

(a) G.A (b) B.A (c) R.A (d) all

Q Zoospore present in

(a) G.A (b) B.A (c) Both a & b (d) R.A

Q Asexual spore Absent in

(a) Bryophyte
(b) Pteridophyte
(c) Gymnosperm

(d) all

cell theory

Reproduction in Algae – Sexual Reproduction in Algae

- Algae is haploid, They show true Sexual Reproduction (Form gametes & Zygote)
→ Algae produce Gametes By Mitosis (n)
→ Algae – male sex organ – Antheridium Female sex organ = Oogonium

→ **Type of Gametes**

① Isogamous → Both gamete same morphology (Genetically Different) → they can Both be motile → ♂ ♂
Both can be non-motile → ○ ○

② Anisogamous – Morphology Different → ○ ♂ or ○ ♂

③ Oogamous → Female gamete large → non-motile → Food Reserve Present → ○ (large) Female gamete
Male gamete small → Generally motile → ♂ male gamete (small)

Green Algae — Isogamous, Anisogamous, Oogamous ✓
Brown Algae → Isogamous, Anisogamous, Oogamous ✓
Red Algae → only oogamous (But male gamete is also non-motile)

(a) Isogamous → Motile → Chlamydomonas, Ulothrix, Cladophora
→ non-motile — Spirogyra

(b) Anisogamous → Eudorina

(c) Oogamous → Ex - Fucus (B.A)
- Volvox (G.A)

Q Few Ex - Fucus, Volvox, Porphyra, Eudorina, Gelidium
Ulothrix (R.A) (R.A)

How many oogamous
(a) three (b) four (c) Fix (d) six

Q non-motile gamete present in
(a) Kelp (b) Ulothrix
(c) Porphyra (d) Chlamydomonas

Q Isogamous non-motile
(a) Porphyra (b) Spirogyra
(c) Fucus (d) Ulothrix-mot

DOPA -

Q1 Gelidium not have Feature :- R.A
(a) Flagella (b) Chla (c) Phycoerythrin (d) all

Q2 Porphyra R.A and Ectocarpus B.A have common
(a) lateral Flagella (b) life cycle (c) Chla (d) all

Q3 Which is motile
(a) Zoospore of Kelp (b) Chlorella (c) Zoospore of Gracilaria (d) all

Q4 Filamentous branch is all Except R.A
(a) Kelp (b) Euglenoids (c) Ectocarpus (d) Cladophora
× = single cell

Q5 Few Ex- Chlamydomonas, Chlorella, Gracilaria, Gelidium, Porphyra
G.A G.A R.A R.A R.A

G.A ← Chla & Chlb present in
(a) three (b) Four (c) two (d) Five

Q6 Not true about Fucus — B+A

(a) Zygotic meiosis (b) Chl a (c) Chl c (d) Algin

Q7 Haplodiplontic plant with zoospore

(a) Marchantia (b) Kelp (c) Polysiphonia (d) Chlamydomonas

Q8 Diplontic life cycle present in

(a) Spermatophyte (b) Pinus (c) Fucus (d) all

Q9 Floridean starch is similar to

(a) Amylose (b) Amylopectin (c) Starch (d) Mannitol

Q10 Wrong Match

(a) Chlorella – Chl b (b) Dictyota – Mannitol — B.f

(c) Polysiphonia – Zygotic Meiosis (d) Porphyra – Aplanospore — R+

E

Importance of Algae

① Algae is producer in Oceans (More than 50% CO_2 Fix)

② Algae (Oxygenic photosynthesis) ⟶ Increase O_2 level in Surrounding

③ Algae come First in Food chain (Aquatic Ecosystem)

④ 70 marine species of Algae – which is Edible
Porphyra, Laminaria, Sargassum

⑤ Brown Algae – cell wall – Algin
Red Algae – cell wall – Carrageen } – water hold
So called Hydrocolloid (Phycocolloid)

cell theory

laminaria

(6) Red Algae ⟶ Gelidium, Gracilaria } ⟶ Chemical obtain Agar-Agar → (जमा देता है) Sodify

Use in Culture of Microbe

Jellies & ice cream

Medium + Agar

(7) Chlorella – Green Algae (tablets)

(Source of Protein)

↳ Use By Space traveller – As a source of Food

cell theory

Algae are useful to man in a variety of ways. At least a half of the total carbon dioxide fixation on earth is carried out by algae through photosynthesis. Being photosynthetic they increase the level of dissolved oxygen in their immediate environment. They are of paramount importance as primary producers of energy-rich compounds which form the basis of the food cycles of all aquatic animals. Many species of *Porphyra*, *Laminaria* and *Sargassum* are among the 70 species of marine algae used as food. Certain marine brown and red algae produce large amounts of hydrocolloids (water holding substances), e.g. **algin** (brown algae) and **carrageen** (red algae) which are used commercially. Agar, one of the commercial products obtained from *Gelidium* and *Gracilaria* are used to grow microbes and in preparations of ice-creams and jellies. *Chlorella* a unicellular alga rich in proteins is used as food supplement even by space travellers. The algae are divided into three main classes: **Chlorophyceae, Phaeophyceae** and **Rhodophyceae**.

Classification of Algae

Algae Divided into three Classes

(a) Green Algae – Chlorophyceae

(b) Brown Algae – Phaeophyceae

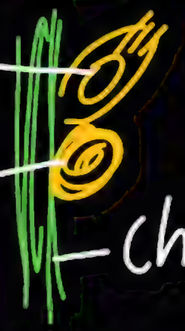
(c) Red Algae – Rhodophyceae

cell theory

	Chlorophyceae	Pheophyceae	Rhodophyceae
Habitat	Fresh water mainly But Marine also (Few)	Marine	Marine — deep sea, Warm water
Structure	Unicellular — Chlamydomonas (motile), Chlorella (non-motile) Colonial — Volvox Filamentous — Ulothrix, Cladophora, Spirogyra (Branch) → Chara → (Branch Filamentous)	Multicellular Filamentous Branch Branch Simple Branch Ex - Ectocarpus Profusely Branch Ex - More Branch Kelp (Grow 100 m)	→ Multicellular Filamentous Branch — Frond & Hold Fast Present

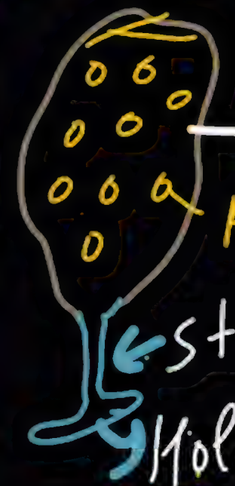
(Female sex organ) Oogonium (Upper)

Antheridium (male sex organ)



— Chara (sex organ)

Brown Algae — thallus three part



① — Frond — main Photosynthetic

Air Bladder

stipe

Hold Fast (Attachment

cell theory

	Chlorophyceae	Phaeophyceae	Rhodophyceae
- Cell wall	Cellulose + Pectin	Cellulose + Algin	Cellulose + Carageen Polysulphate Ester
- Flagella	2-8 Apical Equal	2, lateral Unequal	Absent
- Pigment	Chla & chlb - Different shape of Chloroplast - Cup shape Spiral, Reticulate Ribbon shape - Inside chloroplast Pyrenoid present (Store protein beside starch)	Chla & chl c, Fucoxanthin Olive Green to Brown Colour with the Amount of Fucoxanthin type of Xanthophyll	Chla & chld γ - Phycoerythrin (Red pigment)
Storage	Starch + oil	Laminarian starch Mannitol	Floridian Starch Similar to Amylopectin & Glycogen

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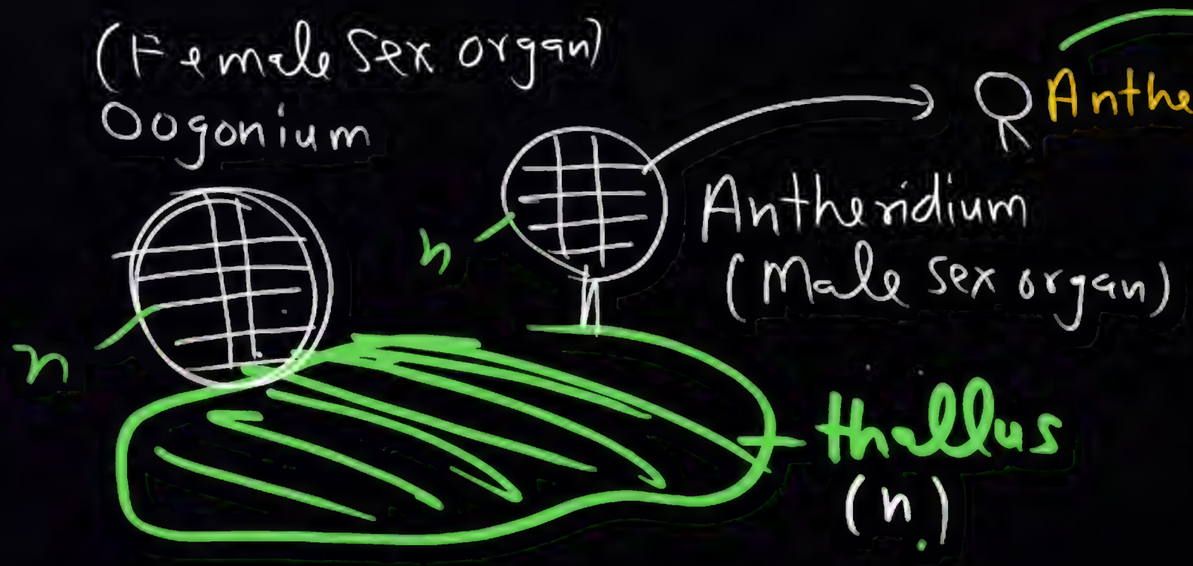
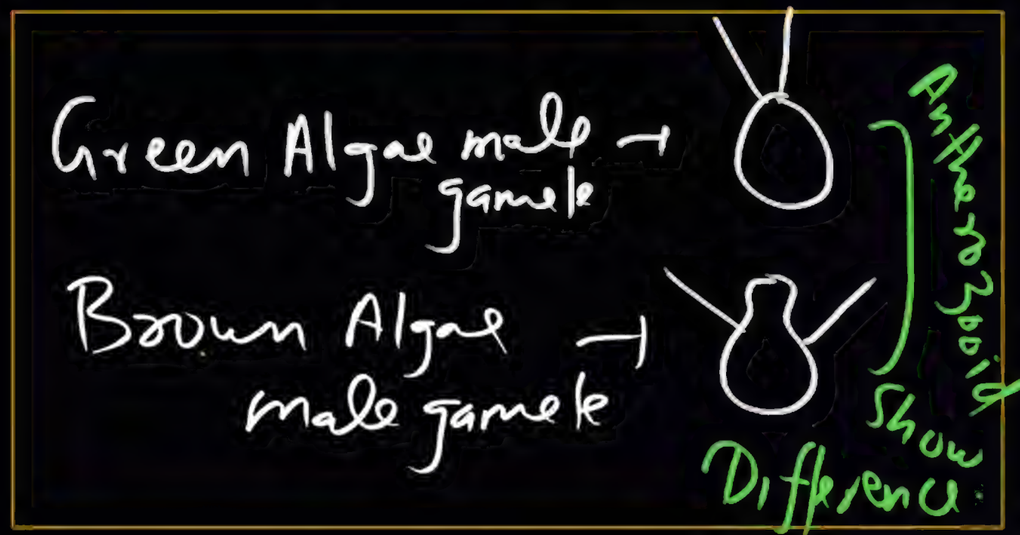
	Chlorophyceae	Phaeophyceae	Rhodophyceae
Reproduction			
Asexual Reproduction	Fragmentation — Zoospore (2-8 Flagella, Apical)	Fragmentation — Zoospore (2, lateral, Unequal)	Fragmentation — Aplanospore (non-motile spore)
Sexual Reproduction	— Isogamous → Spirogyra – non motile Cladophora, Ulothrix – motile — Anisogamous – Eudorina — Oogamous – Volvox	— Isogamous — Anisogamous — Oogamous – Fucus	all Red Algae Oogamous – Complex post Fertilization Changes (– male gamete – non-motile also)
Sex organ	— Oogonium → Female gamete (Egg) – gamete	– Brown Algae Oogonium & Antheridium present	
	Male sex organ – Antheridium Gamete (motile) – Antherozooid ↓ gamete	– male gamete → (Antherozooid) Pear shape	

Cell theory



Antherozooid (male gamete) — single cell haploid

Flagella



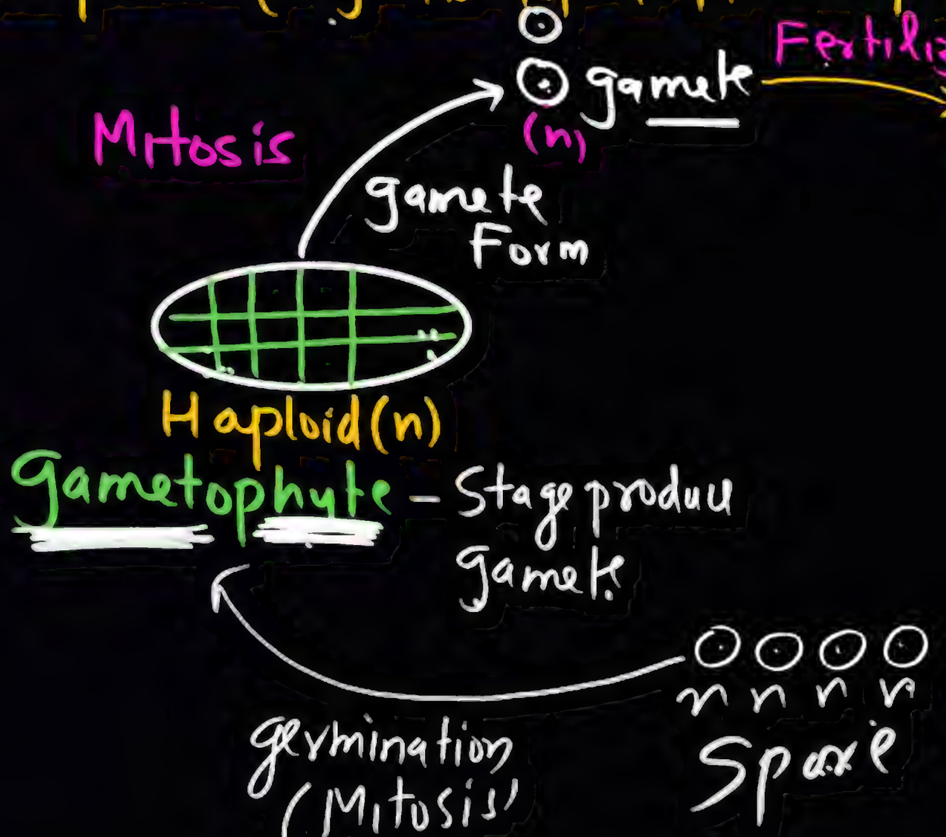
Sex organ in Algae

(a) Oogonium – Female sex organ
– haploid, multicellular] — Produce Egg(n), single cell, no Flagella

(b) Antheridium → Male sex organ → Produce male gamete → ♂ Antherozooid
– haploid, Multicellular

Sexual Reproduction in plant Kingdom

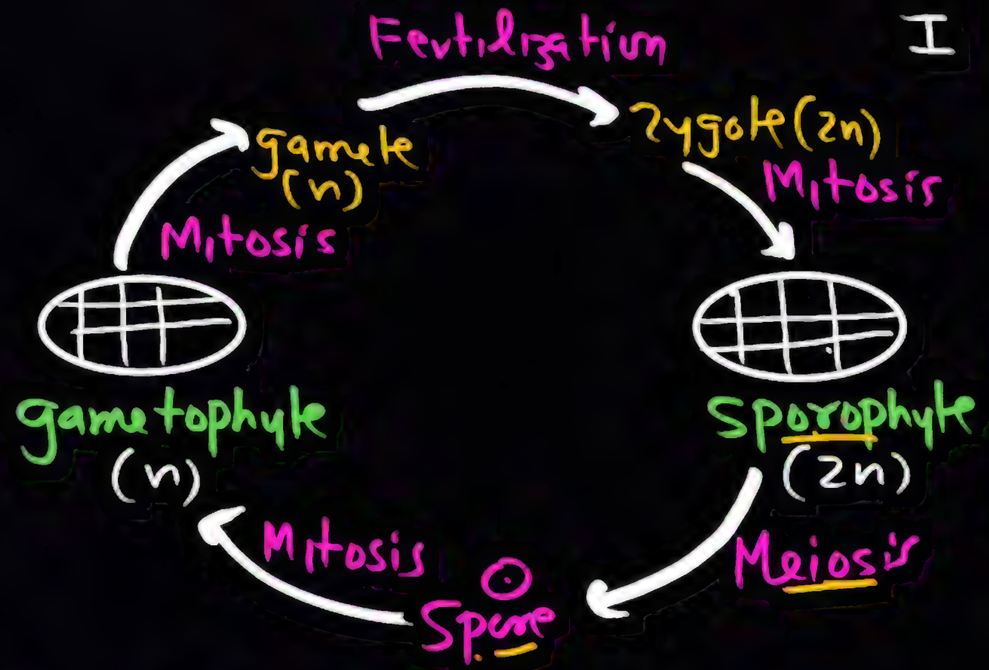
- All plants (Algae, Bryophyte, Pteridop, Gymno & Angio) → Both haploid & Diploid phase present — Life cycle



* Gametophyte stage produce Gametes, it is haploid & Multicellular

* Sporophyte stage - Diploid & Multicellular & Produce Spore By Meiosis

* All plants have Both these stages Sporophyte & Gametophyte



I **Haploid plants** – Gametophyte stage is main plant, Dominant (Green, photosynthetic)
Ex- Algae, Bryophyte

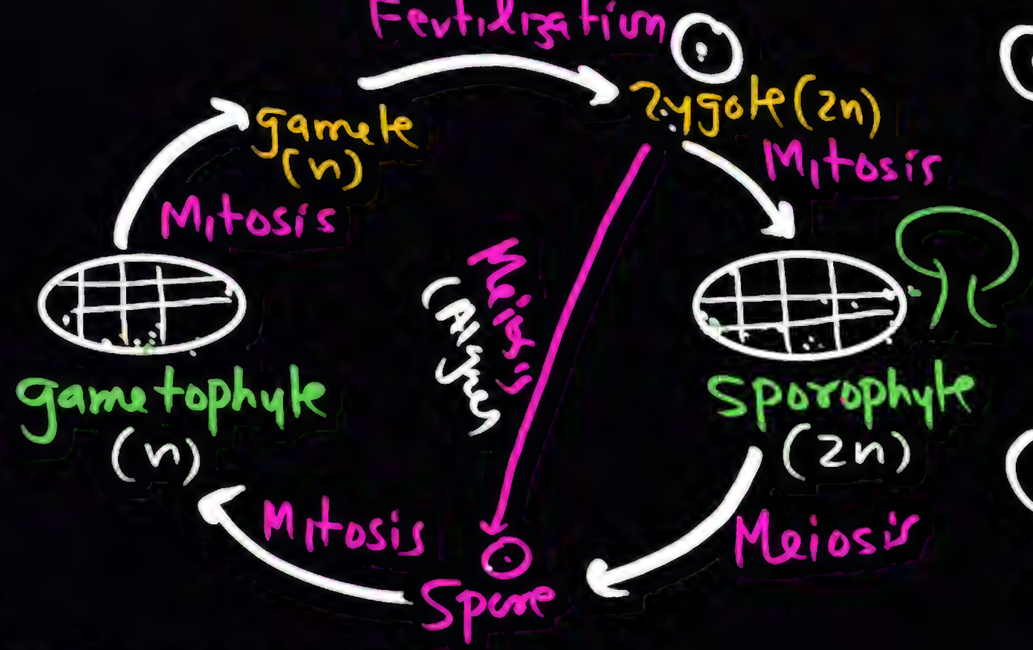
II **Diploid plants** – Sporophyte stage Green, photosynthetic Dominant (For more time)
Ex- Pteridophyte, Gymnosperm, Angiosperm)

Q Which is haploid plant
(a) Equisetum (Pte) (b) Pinus (Gymno) (c) Marchantia (Bryo) (d) NEEM (Ang)

Q Gametophyte stage is Dominant main plant Body
(a) Sphagnum (Bry) (b) Cycas (Gy) (c) Rose (An) (d) Pteris (Pt)

Q Sporophyte is Green photosynthetic, main plant Body in
(a) Cladophora (Alg) (b) Selaginella (Pt.)
(c) Funaria (Bry) (d) Chlamydomonas (Alg)

cell theory



Life cycle :-

⊙ Haplontic life cycle → Algae
→ Zygotic meiosis occur

(Diploid stage is Reduced → very less cell
Zygote undergo mitosis

⊙ Diplontic life cycle (Gymno, Angio)

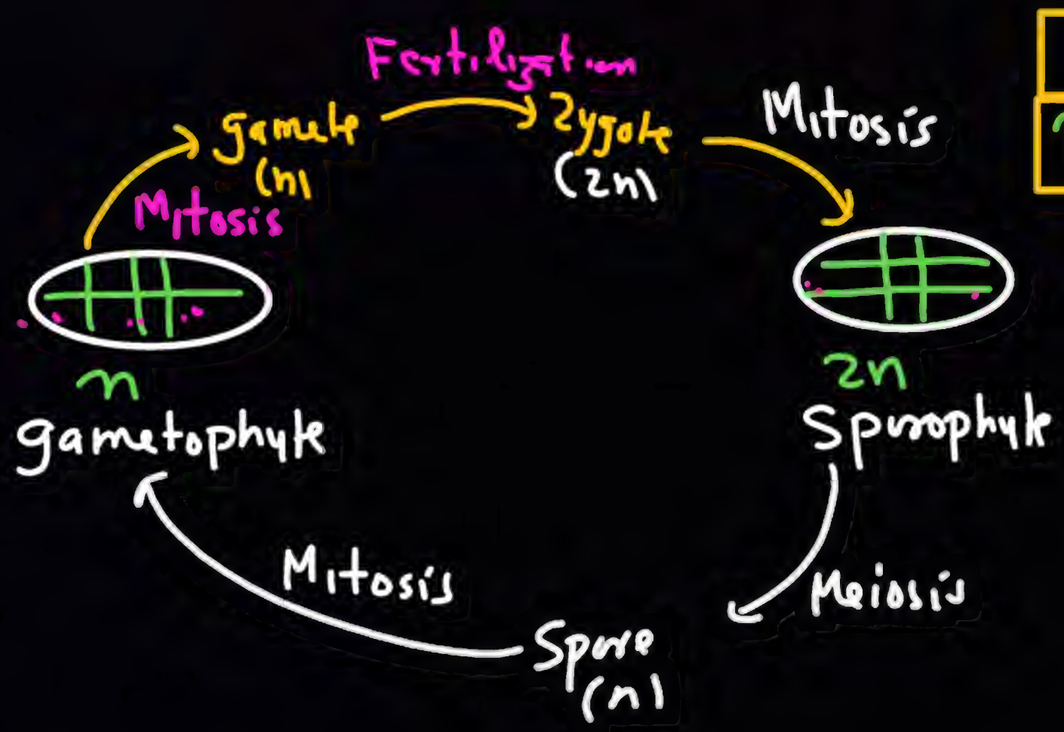
- Very less cells in gametophyte
Ex - Pollen Grain - only 3 cells)

⊙ Haplodiplontic

- gametophyte & sporophyte - Both have Sufficient no of cells

Ex - Bryophyte - main stage - gametophyte

- Pteridophyte - main stage - Sporophyte (2n)
(Diploid



Haploid – main Plant, Gametophyte – Green → Algae, Bryophyte

Diploid → main plant Body Sporophyte
Green, Dominant → Pteridophyte, Gymno, Angio

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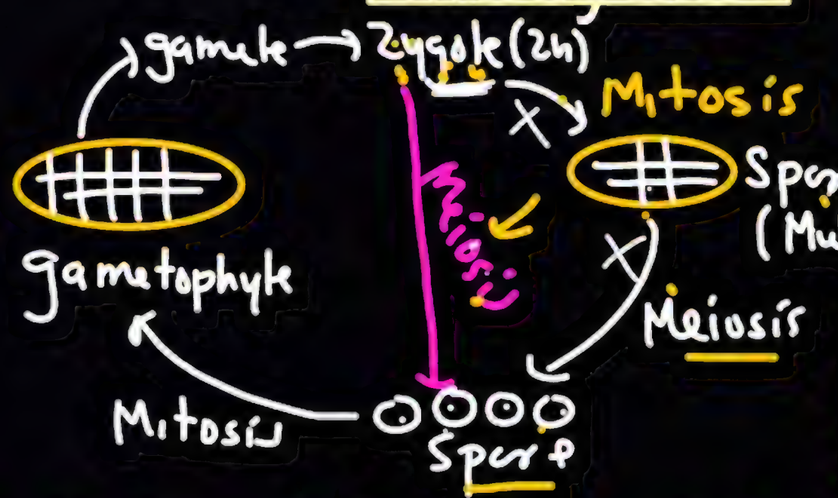
lifecycle



→ **haplontic** – haploid stage – large no. of cells
Diploid stage Reduces – Very less cells
– In this life cycle – Zygotic Meiosis
⇒ Sporophyte is Single cell Zygote
⇒ Zygotic mitosis not occur

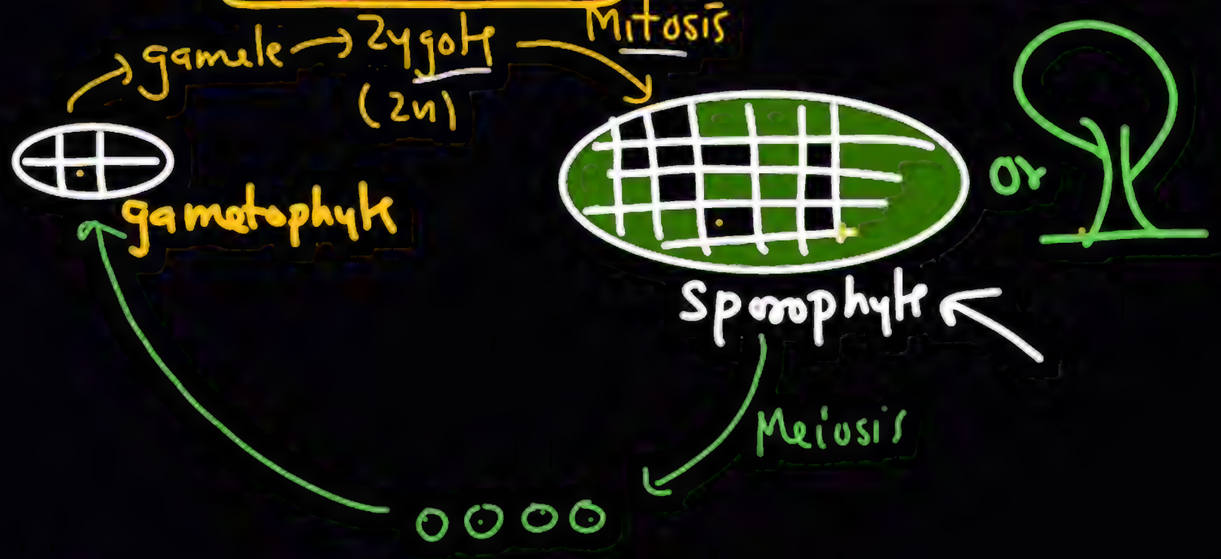
Ex – All Algae show this type of life cycle
Except
[Kelp, Ectocarpus, polysiphonia – Haplodiplontic
Fucus – Diplontic

Q Multicellular Sporophyte Absent in – Haplontic life cycle
(a) Kelp (b) Marchantia (Bry)
(c) Fucus (d) Ulothrix
Al Al

→ Zygotic meiosis occur in
(a) Chlamydomonas (b) Ectocarpus ✗
(c) Pinus. (d) Rose →

Q Meiosis occur in Single cell Zygote in all Except
(a) Ulothrix (b) Fucus (c) Chlamydomonas (d) Spirogyra

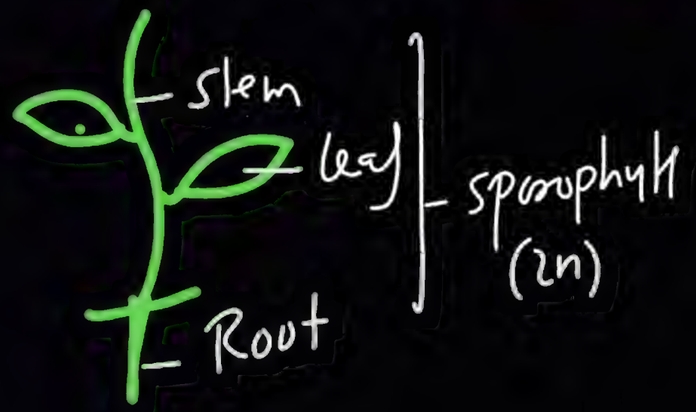
Diplontic



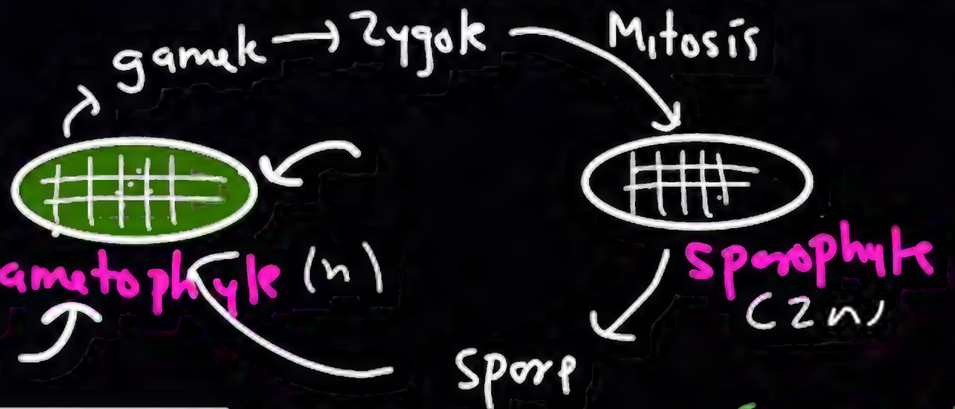
→ gametophyte stage-Reduces
(Very less cells)

Ex- [Gymnosperm, Angiosperm] — They are Diploid
(Sporophyte Green Dominant)

Diplontic → Gametophyte stage Reduce (less no. cells)



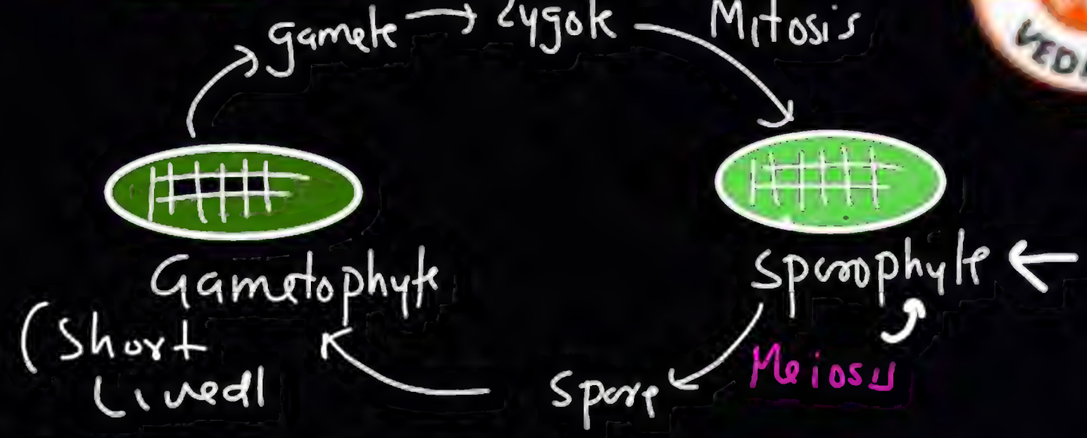
Haplo diplontic – gametophyte & sporophyte large no. of cells



Bryophyte – Plant Haploid (Green) – main stage gametophyte

– For more time

Ex- Haplodiplontic → Bryophyte, Pteridophyte



Pteridophyte – Both gametophyte & Sporophyte Green

But Sporophyte – long lived (Diploid plant)

→ Main stage – Sporophyte

	Algae	Bryophyte	Pteridophyte	Gymno	Angio
Main plant Body →	Gametophyte	Gametophyte	Sporophyte	Sporophyte	Sporophyte
life cycle →	Haplontic (Exception)	Haplodiplontic	Haplodiplontic	Diplontic	Diplontic
Ploid → (n or 2n)	n	n	2n	2n	2n
Zygotic meiosis	✓	X	X	X	X
Zygote mitosis	X	✓	✓	✓	✓

Q Which is Haplodiplontic
(a) Algae (b) Bryophyte (c) Moss (d) Both b & c

Q Which is Haplodiplontic
(a) Ulothrix (b) Pteris (c) Pinus (d) Banyan
Alg Pt Gym Ang

Q Main plant Body is Gametophyte in — Alg | Bryo
(a) Ulothrix (Al) & Pinus (Gym)
(b) Porphyra (Al) & Marchantia (Br)
(c) Lycopodium (Pt) & Sphagnum (Bry)
(d) Pinus (Gy) & Cedrus (Gy)

→ haploid plant

Bry Pte

Q Which is Haplodiplontic
haploid plant → Alg + Bry
(a) Polytrichum – Bry
(b) Spirogyra – Al
(c) Selaginella – Pt
(d) all ✗

Q Few Ex are Given

Bry Gym Pt Ang Alg Alg-Hd Alg-D
Sphagnum, Sequoia, Pteris, Neem, Ulothrix, Ectocarpus, Fucus

Bry Gym
Marchantia, Pinus

2 1
(a) Haplodiplontic — Bry + Pte [Kelp Ecto Polysiph] = 4

(b) Diplontic — Gym + Ang (Exceptions - Fucus) = 4

(c) Zygotic meiosis → Alg → 1

(d) Zygotic Mitosis

2 1 2 1
→ Bry + Pte + Gym + Ang + Ex (2)

Hd D

= 8

4418

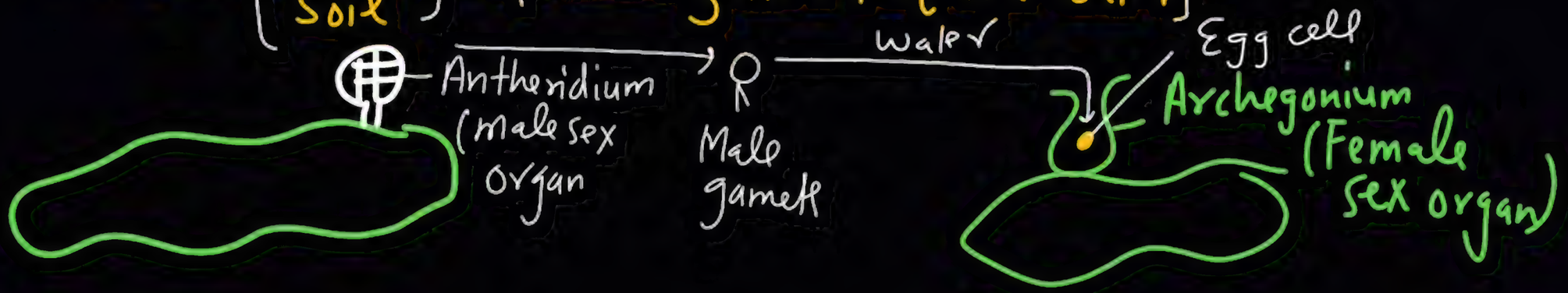
Bryophytes

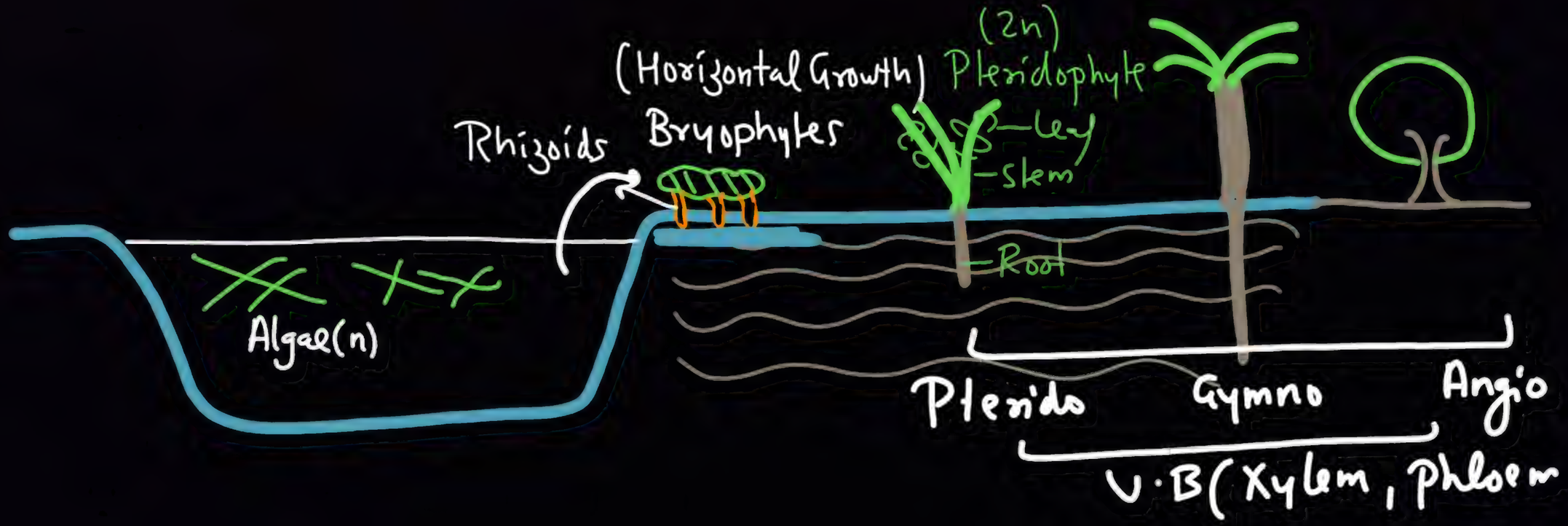
Habitat → Moist, Humid & Shady Region (Some Hilly Region)

(Grow where soil have moisture)

→ They are called plant Amphibian

Bryophyte [Grow in Soil] → [Fertilization Require water]




(2n)
(Horizontal Growth)
Pteridophyte
Bryophytes
Rhizoids
Leaf
Stem
Root
Algae(n)
Ptérido
Gymno
Angio
V.B(Xylem, Phloem

DOPA

Q1 haplontic life cycle present in
(a) Ulva (b) Ectocarpus (c) Polysiphonia (d) none

Q2 Zygotic Meiosis occur in
(a) Marchantia (b) Fucus (c) Cladophora (d) Funaria

Q Haplodiplontic Haploid
(a) Sphagnum (b) Polytrichum (c) Funaria (d) a&b

Q Haplodiplontic Diploid
(a) Pinus (b) Pteris (c) Cycas (d) NEEM

Q leaf of Banyan is
(a) haploid (b) Diploid (c) Sporophytic Generation (d) Both b&c

Q7 Similarity in Salvinia & Sequoia

(a) life cycle (b) Diploid (c) haploid (d) all

Q8 Zygotic Mitosis occur in

(a) Haplodiplontic (b) Diplontic (c) Diploid plants (d) all

Q9 S-I Haplontic plant never be Diploid

S-II Diplontic plant never be haploid

Q10 S-I Haplodiplontic plant can be Haploid

S-II Haplodiplontic plan can be Diploid

Q11 S-I - Sporophyte stage Absent in Haplontic plant

S-II Gametophyte stage Absent in Diplontic plant

Q12 S-I Diploid plants can have gametophyte stage

S-II Ectocarpus show Zygotic Meiosis

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Plant kingdom

lecture - 5

Botany

TARUN SIR

Topics

- Algae
- Bryophyte
- pteridophyte
- Gymnosperm
- Angiosperm

2 no of Question + 3 → 12 Marks

cell theory

Today's Goal

Basics of Algae

cell theory

DOPA

Q) Haplontic life cycle present in
(a) Kelp (b) Ectocarpus (c) Polysiphonia (d) none ✓

Q2 Zygotic Meiosis occur in (Algae)
(a) Marchantia (b) Fucus (c) Cladophora (d) Funaria
Bry Diplo Bry

Q Haplodiplontic Haploid (Bry)
(a) Sphagnum (b) Polytrichum (c) Funaria (d) Fern

Q Haplodiplontic Diploid (Pte)
(a) Pinus (b) Pteris (c) Cycas (d) NEEM

Q Leaf of Banyan is Angio = Sporophyte
(a) haploid (b) Diploid (c) Sporophytic Generation (d) Both b & c

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hd – pte Gym – D

Q7 Similarity in Salvinia & Sequoia
(a) life cycle (b) Diploid (c) haploid (d) alp

Q8 Zygotic Mitosis occur in
(a) Haplodiplontic (b) Diplontic (c) Diploid plants (Pte, Gym, Any) (d) alp

Q9 S-I Haplontic plant never be Diploid (Zygote)
S-II Diplontic plant never be haploid (Pte, Gym)

Q10 S-I Haplodiplontic plant can be Haploid (Bry) → B|D
S-II Haplodiplontic plan can be Diploid (Pte)

Q11 S-I – Sporophyte stage Absent in Haplontic plant
S-II Gametophyte stage Absent in Diplontic plant

Q12 S-I Diploid plants can have gametophyte stage
S-II Ectocarpus show Zygotic Meiosis (Hd)

detail structure of Bryophyte

cell detail – Single cell detail in Bryophyte

- Cell wall – Cellulose
- Flagella – only in male gametes (Asexual spore Absent)
- Pigment – chl a & chl b → Pteridophyte, Gymnosperm, Angiosperm – Same pigment
- Storage – Starch

Bryophyte – Multicellular

note – now onward cell detail – not study

cell theory

External structure – multicellular, thallus like (no proper shape) → Fragmentation occur

– Thallus of Bryophyte – more Advance than Algae]

– main plant Body ⟶ Gametophyte – thallus of Bryophyte = haploid plant

---

thallus ⟶ two type

(a) Horizontal, Flat, creeping

– gametophyte (n)

– (n) Rhizoids – hair like – Attachment to Substratum]

(b) Erect (सीधा) – not Grow with much height

(n)

– Leaf like structure

– stem like structure (n)

– Rhizoids (Root like structure (n)

note – Bryophyte main plant – Gametophyte – Green, Photosynthetic, haploid

↳ True Root, stem, leaf → Absent → Root, leaf stem like structure

The plant body of bryophytes is more differentiated than that of algae. It is thallus-like and prostrate or erect, and attached to the substratum by unicellular or multicellular rhizoids. They lack true roots, stem or leaves. They may possess root-like, leaf-like or stem-like structures. The main plant body of the bryophyte is haploid. It produces gametes, hence is called a **gametophyte**. The sex organs in bryophytes are multicellular.

cell theory

Sex organ on Bryophytes

- main plant Body - Gametophyte - to produce gamete
  - Gamete produce on male sex organ - Antheridium
  - Female sex organ - Archegonium

- Male gamete (n) - Antheroozooid - Biflagellated
- Antheridium (n) - Male - Multicellular - Produce motile male gametes - By Mitosis
  - Sex organ
- male gametophyte (n)

Note - Antheridium and Archegonium can present on Different thallus & Same thallus

- Archegonium (n) - Female sex organ - Multicellular - Produce Female gamete By Mitosis
  - Flask Shape
  - Produce non-motile Egg cell
- Female gametophyte

cell theory

(Alg, Bry)

Q1 haploid Plant is

(a) Marchantia (b) Ulothrix (c) Funaria (d) all

Bry Alg Bry

Asexual Spore → Zoospore (F.A) (Alg) ; Aplanospore (N.A)

Q2 Zoospore present in (Bryophyte Asexual spore Absent)

(a) Kelp (b) Marchantia (c) Funaria (d) all

Q3 Asexual spore Absent in

(a) Polytrichum (b) Porphyra (c) Polysiphonia (d) all

(moss) Aplanospore (Asexual spore) present

Q4 Fragmentation occur in (thallus)

(a) Moss (b) Green Algae (c) Basidiomycetes (d) all

Bryo

cell theory

Uni, Multi

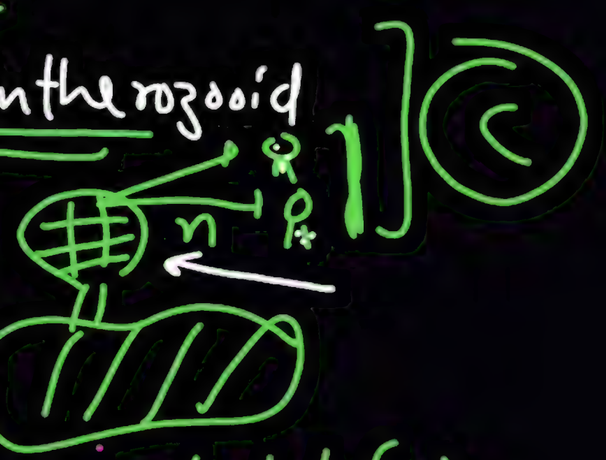
Q1 Which is not Multicellular haploid
Unicellular

(a) Egg (b) Rhizoids (c) Antherozooid (d) ✓

n n n single cell

Q2 S-I → Antheridium produce genotically identical Antherozooid

S-II - Archegonium produce single Egg cell ✓



Q3 S-I → Bryophyte is oogamous (male gamete - motile, Female gamete - non-motile)

S-II Bryophyte show internal Fertilization

cell theory

Reproduction in Bryophyte

Asexual Reproduction → Bryophyte lack Any Asexual spore (not Zoospore not Aplanospore)

(a) Fragmentation occur (structure thalloid)

(b) Marchantia (Genus) → Come in liverwort Group ⟶ Gemmae Bud ✓

(c) Moss (Group) ⟶ Budding in Protonema ✓

Q Spore produce By Mitosis Absent in

(a) Ulothrix — Alg

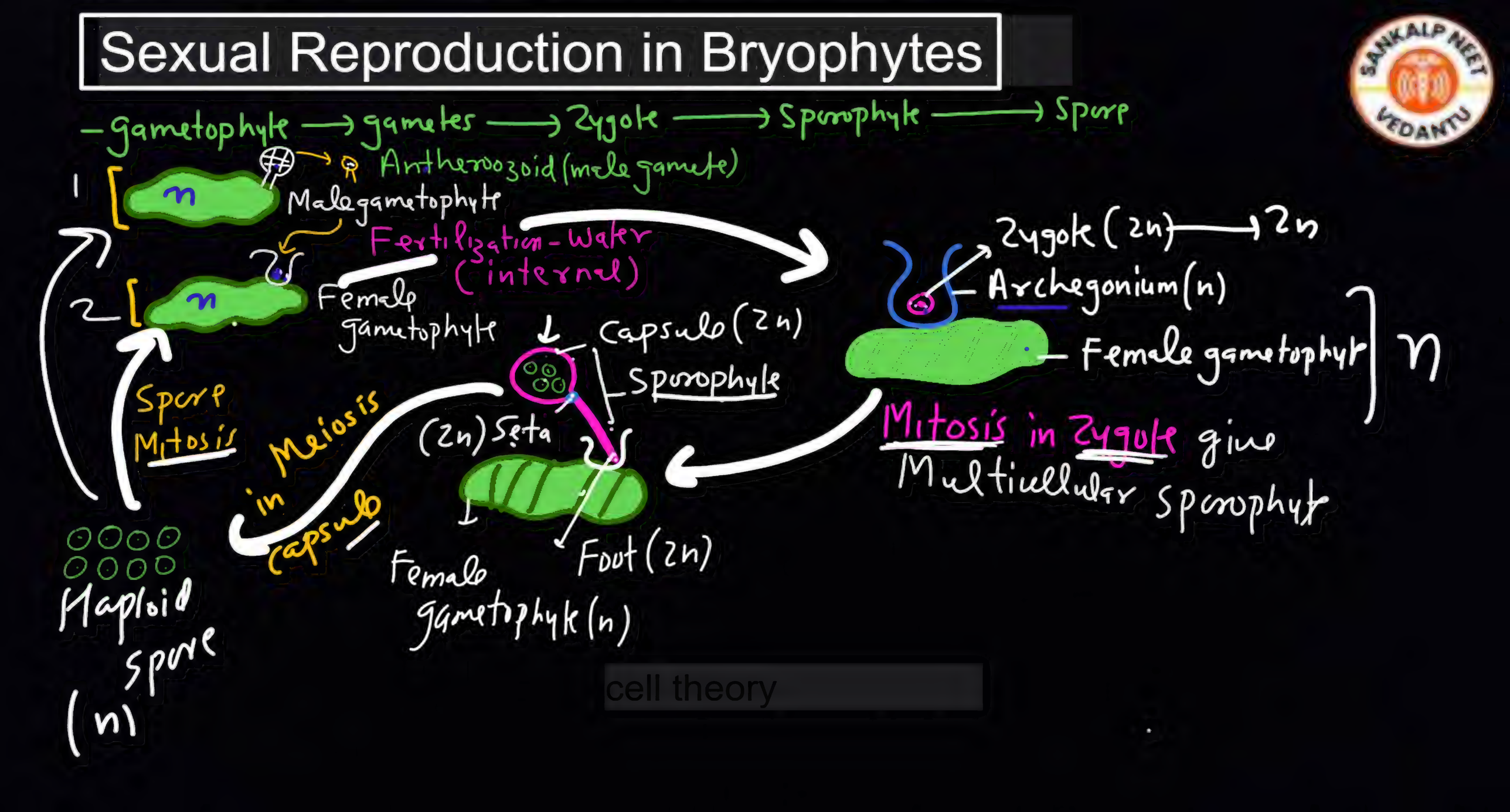
(b) Aspergillus — Fungi

(c) Marchantia — Bry

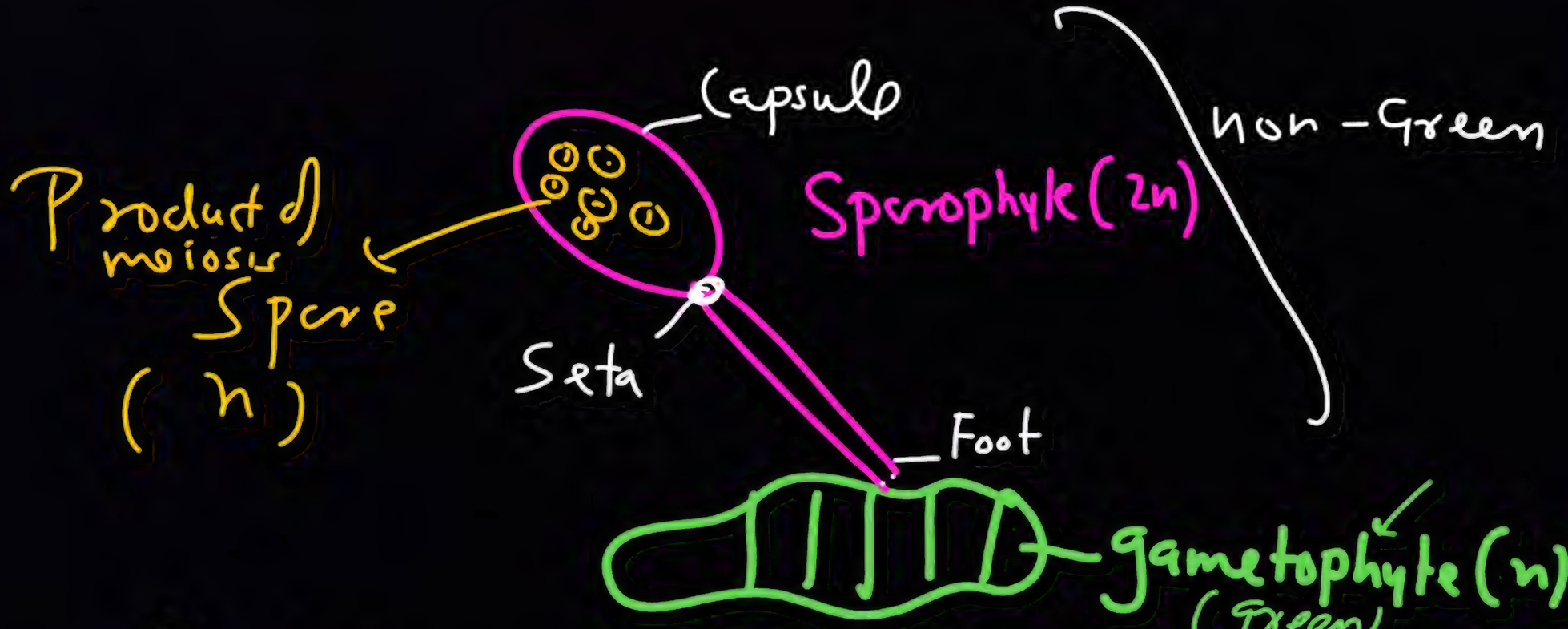
(d) Chlamydomonas — Al

cell theory

Sexual Reproduction in Bryophytes

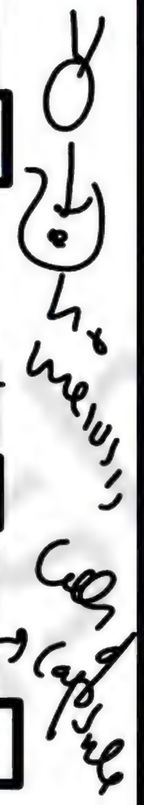


cell theory



- Bryophyte - main plant - **Gametophyte** - Green, photosynthetic, Dominant phase] Free living
- **Sporophyte** - multicellular, non-green, depend on Gametophyte] dependent
- three part - Foot, seta, Capsule
- Meiosis inside capsule → Sexual spore (haploid)

is called a **gametophyte**. The sex organs in bryophytes are multicellular. The male sex organ is called **antheridium**. They produce biflagellate **antherozoids**. The female sex organ called **archegonium** is flask-shaped and produces a single egg. The antherozoids are released into water where they come in contact with archegonium. An antherozoid fuses with the egg to produce the zygote. Zygotes do not undergo reduction division immediately. They produce a multicellular body called a **sporophyte**. The sporophyte is not free-living but attached to the photosynthetic gametophyte and derives nourishment from it. Some cells of the sporophyte undergo reduction division (meiosis) to produce haploid spores. These spores germinate to produce gametophyte.



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Importance of Bryophytes

Bryophytes in general are of little economic importance but some mosses provide food for herbaceous mammals, birds and other animals. Species of *Sphagnum*, a moss, provide peat that have long been used as fuel, and as packing material for trans-shipment of living materia because of their capacity to hold water. Mosses along with lichens are the first

(a) Ecological importance (Less Economic importance)

(b) Use Food By Herbaceous Mammals & Birds

(c) Sphagnum - Use in transhipment of living material

(d) Sphagnum - Peat moss (Use as a Fuel

Importance of Bryophytes

of their capacity to hold water. Mosses along with lichens are the first organisms to colonise rocks and hence, are of great ecological importance. They decompose rocks making the substrate suitable for the growth of higher plants. Since mosses form dense mats on the soil, they reduce the impact of falling rain and prevent soil erosion. The bryophytes are divided into **liverworts** and **mosses**.

(e) Plant Sucession - Bare Rock
First Lichen grow then moss grow

(f) Moss Form dense mat → prevent Soil Erosion

cell theory

MANTHAN NEET 2025 -

1.0 and 2.0

Plant kingdom

lecture - 6

Botany

TARUN SIR

Topics

- Algae
- Bryophyte
- pteridophyte
- Gymnosperm
- Angiosperm

no of Question → 3 → 12 Marks

① lecture →
② DPP →
③ DOPA prime
④ NCERT Deeplines

cell theory

Topics

- Algae
- Bryophyte
- pteridophyte
- Gymnosperm
- Angiosperm

no of Question × 3 ⟶ 12 Marks

cell theory

II

Bryophytes

- Liverworts → Marchantia ←
- Moss → Sphagnum, Polytrichum, Funaria

III

Pteridophytes

Fern

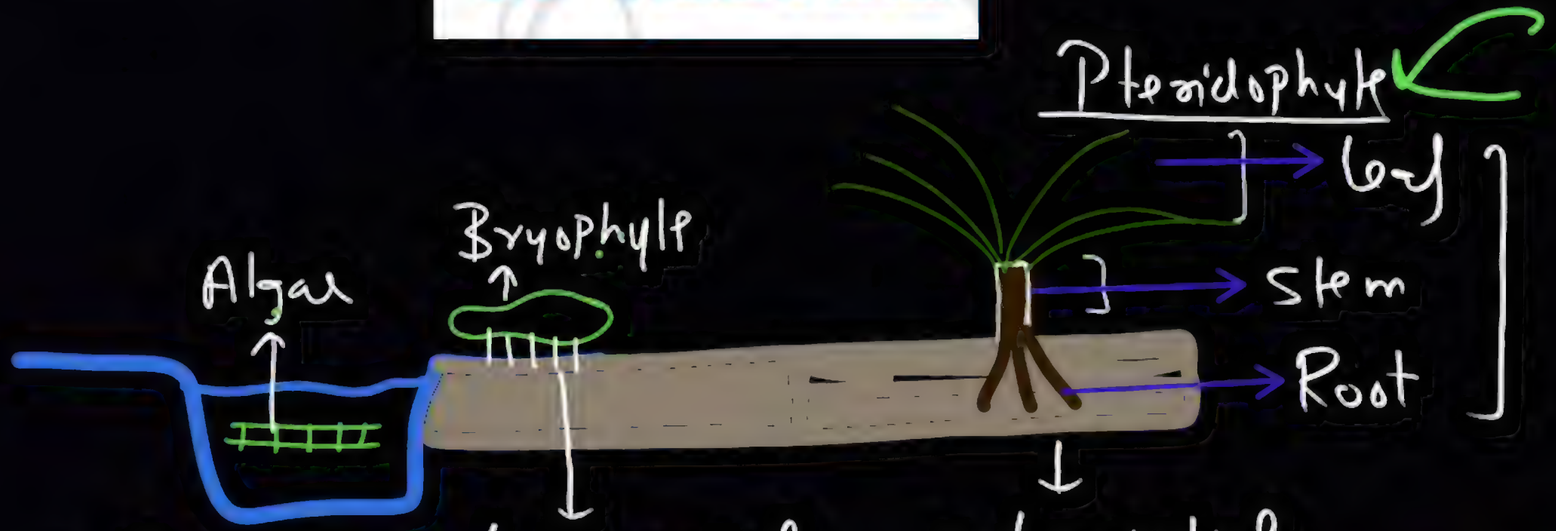
1. Psilopsida → - Psilotum ✓
2. Pteropsida - Pteris, Dryopteris, Adiantum, Azolla, Salvinia
3. Sphenopsida - Equisetum (Horse tail)
4. Lycopsida - Selaginella, Lycopodium

IV

Gymnosperm →

Conifers - Pinus, Cedrus
- Cycas
- Sequoia, Ginkgo
(tallest tree)

3.3 Pteridophytes



- Aquatic

Main plant → Gametophyte (thallus)

Haploid

Thallus

Xylem & Phloem → Absent

terrestial

Gametophyte (thallus)

Haploid

Root, stem, leaf like structure → Absent

terrestial

Sporophyte

Diploid plant

True Root, stem & leaf present → Present

cell theory

3.3 PTERIDOPHYTES → Horsetail (Equisetum) & Ferns (main Pteridophyte)

Habitat → Shady place, cool
Some Grow in Sandy soil

(Importance → Some ornamental (सजावट के लिए)
→ Some medicinal, Prevent soil Erosion) – Soil Binder

Structure:- Pteridophyte – Diploid plant – main plant Body – Sporophyte
– First time in Evolution – Vascular Bundle (Xylem & Phloem)
Appear in Pteridophyte
→ True Root, Stem & Leaf present

cell theory

DOPA -

Q1 Oogamous & Algin present in
(a) Volvox (b) Porphyra (c) Fucus (d) all

Q2 Mannitol is present in
(a) Ectocarpus (b) Kelp (c) Dictyota (d) all

Q3 Carrageen, haplontic, motile male gamete, Chl b, Pyrenoid, Oogamous, Algin
How many present in Spirogyra
(a) three (b) Four (c) two (d) Five

Q4 How many of Above present in Porphyra
(a) two (b) three (c) Five (d) Four

Q5 How many present in Kelp
(a) three (b) Four (c) two (d) Five

Q6 Motile male gamete, Zoospore, Fragmentation, Zygotic Mitosis, Zygotic Meiosis
Chla, Chlb, Archegonium
How many present in Marchantia
(a) two (b) three (c) Four (d) Five

Q7 How many of the Above present in Cladophora
(a) three (b) Four (c) Five (d) Six

Q8 How many common in Marchantia & Kelp
(a) three (b) Four (c) Five (d) Six

Q9 Archegonium is Genetically Same to
(a) Zygote (b) Egg cell (c) Spore (d) Antherozoid

Q10 Reduction Division occur in ____ in Bryophyte
(a) Zygote (b) Foot (c) Capsule (d) Seta

DOPA- 1

Q1 Spore Dispersal Mechanism is Eloberate in
(a) Spirogyra (b) Funaria (c) Marchantia (d) all

Q2 Which is part of gametophyte Generation — n
Spore (n), Zygote (2n), leaf in Moss (n), Archegonium (n), Egg (n), Capsule (2n), Foot (2n), Seta (2n)
(a) Four (b) Five (c) Six (d) Seven

Q3 Archegonium Absent in Bry, Pte, Gymn
(a) Marchantia (Bry) (b) Funaria (Bry) (c) Kelp (Alg) (d) Sphagnum (Bry)

Q4 Asexual Spore Absent in (Algae, Fungi)
(a) liver wort (Bry) (b) Fern (Pt) (c) Moss (Bry) (d) all

Q5 Sexual Spore Absent in
(a) Algae (b) Seed bearing plants (c) Moss (d) none.

Q6 Meiosis occur in Spirogyra in ____ and in sphagnum in ____
(a) Zygote, Foot (b) Zygote, Capsule (c) Spore, Zygote (d) all

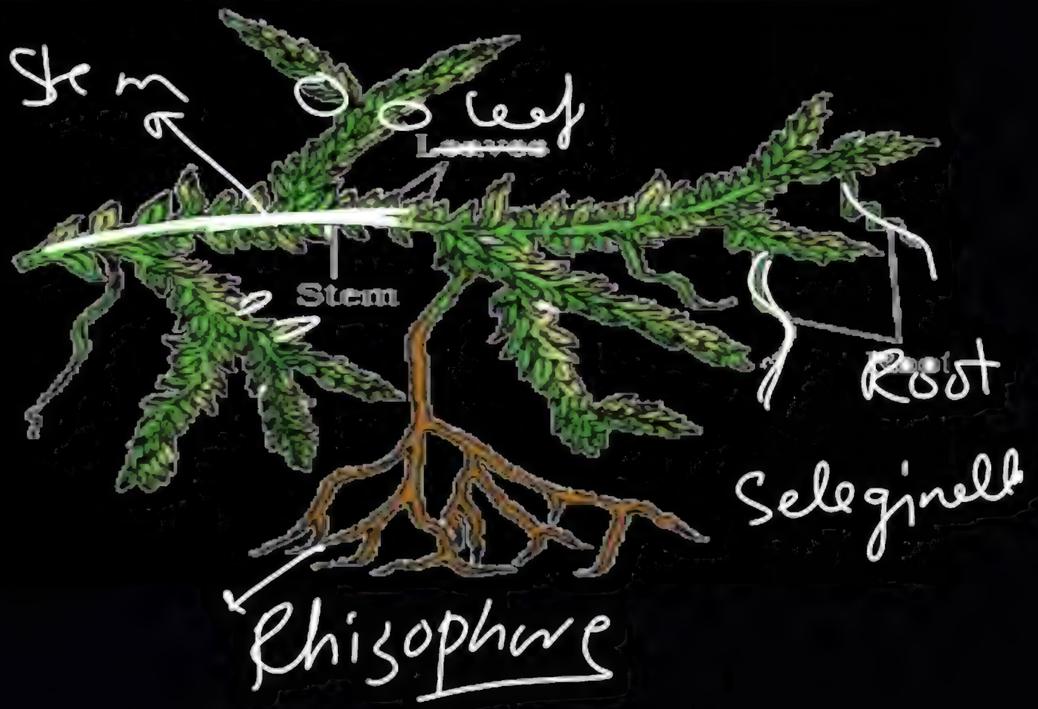
Q7 Zygotic Mitosis in Marchantia give
(a) Free living sporophyte (b) dependent sporophyte
(c) Free living gametophyte (d) all

Q8 Sporophyte is dependent in
(a) Algae (b) Bryophyte (c) Pteridophyte (d) Both 1 & 2

Q9 Haplodiplontic life cycle present in
(a) Sphagnum (b) Polysiphonia (c) Both a & b (d) Spirogyra

Q10 gemma – not true
(a) Green (b) Photosynthetic (c) Free living (d) Diploid

3.3 Pteridophytes



Selaginella

Fern

cell theory

3.3 Pteridophytes

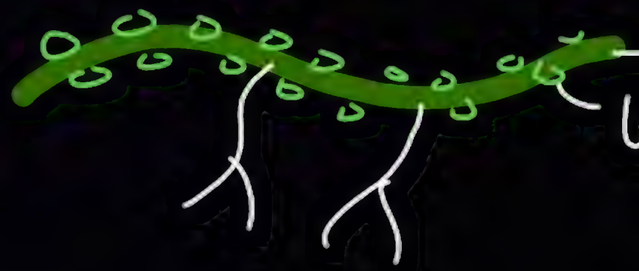
Selaginella

cell theory

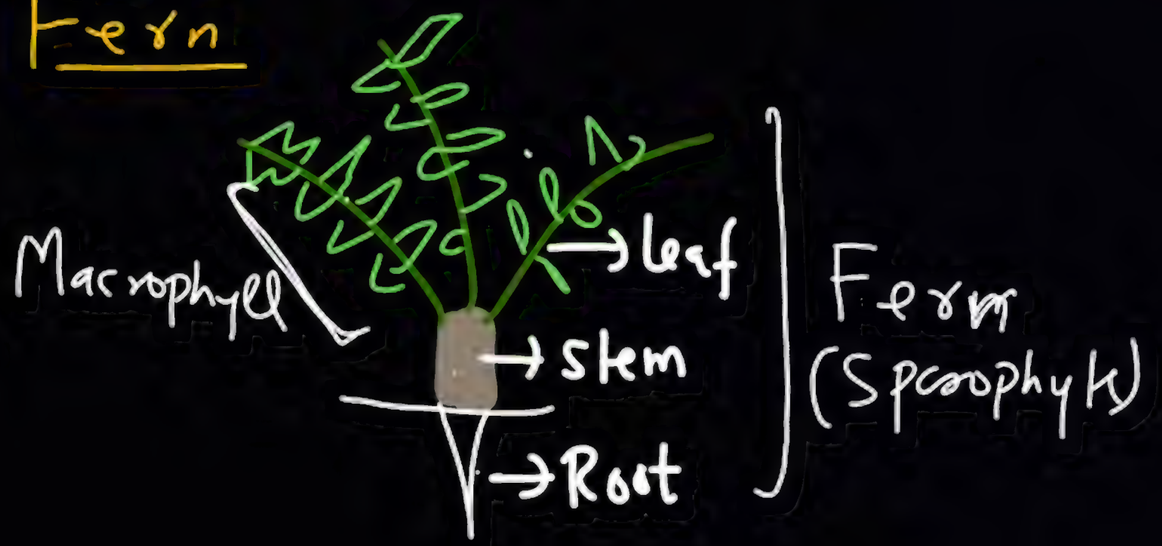
3.3 Pteridophytes — Diploid plant

structure - True Root, stem & leaf present [Sporophyte is Differentiated into Root, stem & leaf]

Selaginella



Fern



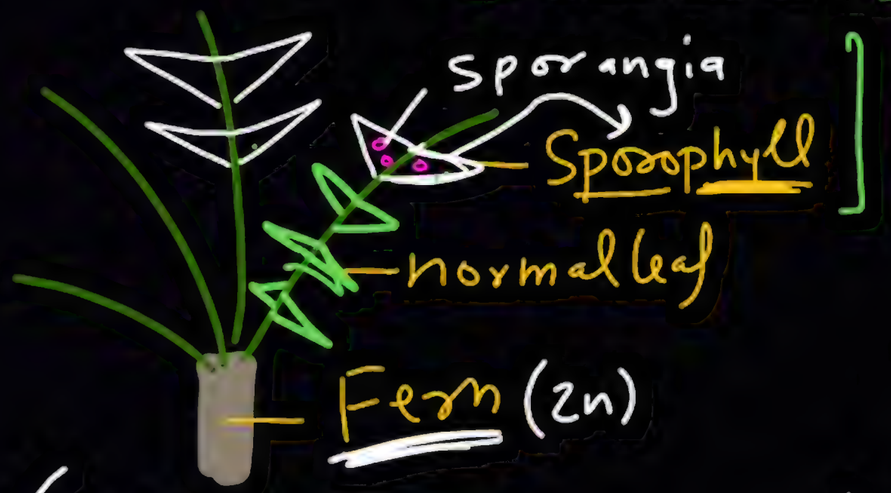
cell theory

3.3 Pteridophytes

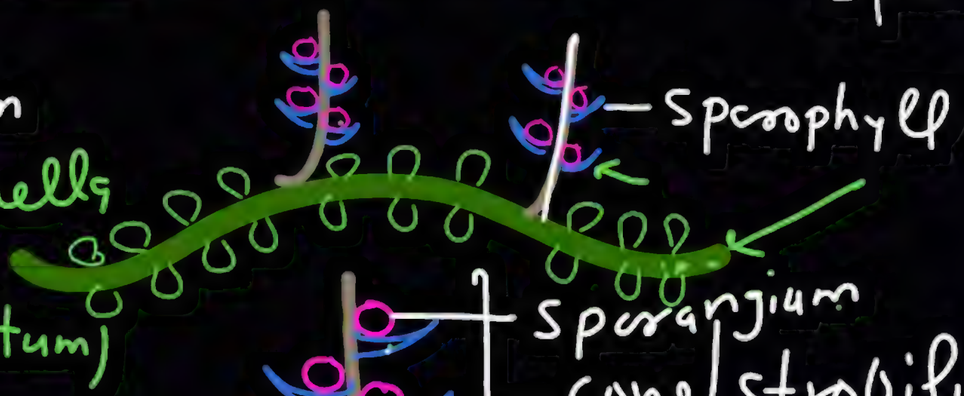
Algae – Meiosis occur in Zygote
Bryophyte – meiosis occur in Capsule
Pteridophyte meiosis occur in Sporangium

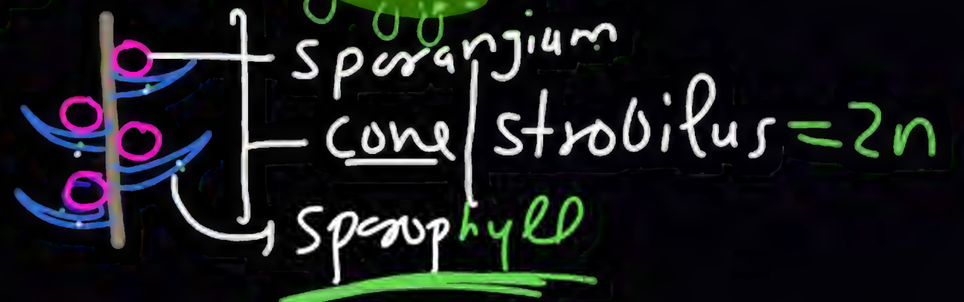
Where does sporangia produced

– Sporangia present on sporophyll
– Sporophyll
  – Randomly present – in Fern
  – In Form of cone (Selaginella, Equisetum)



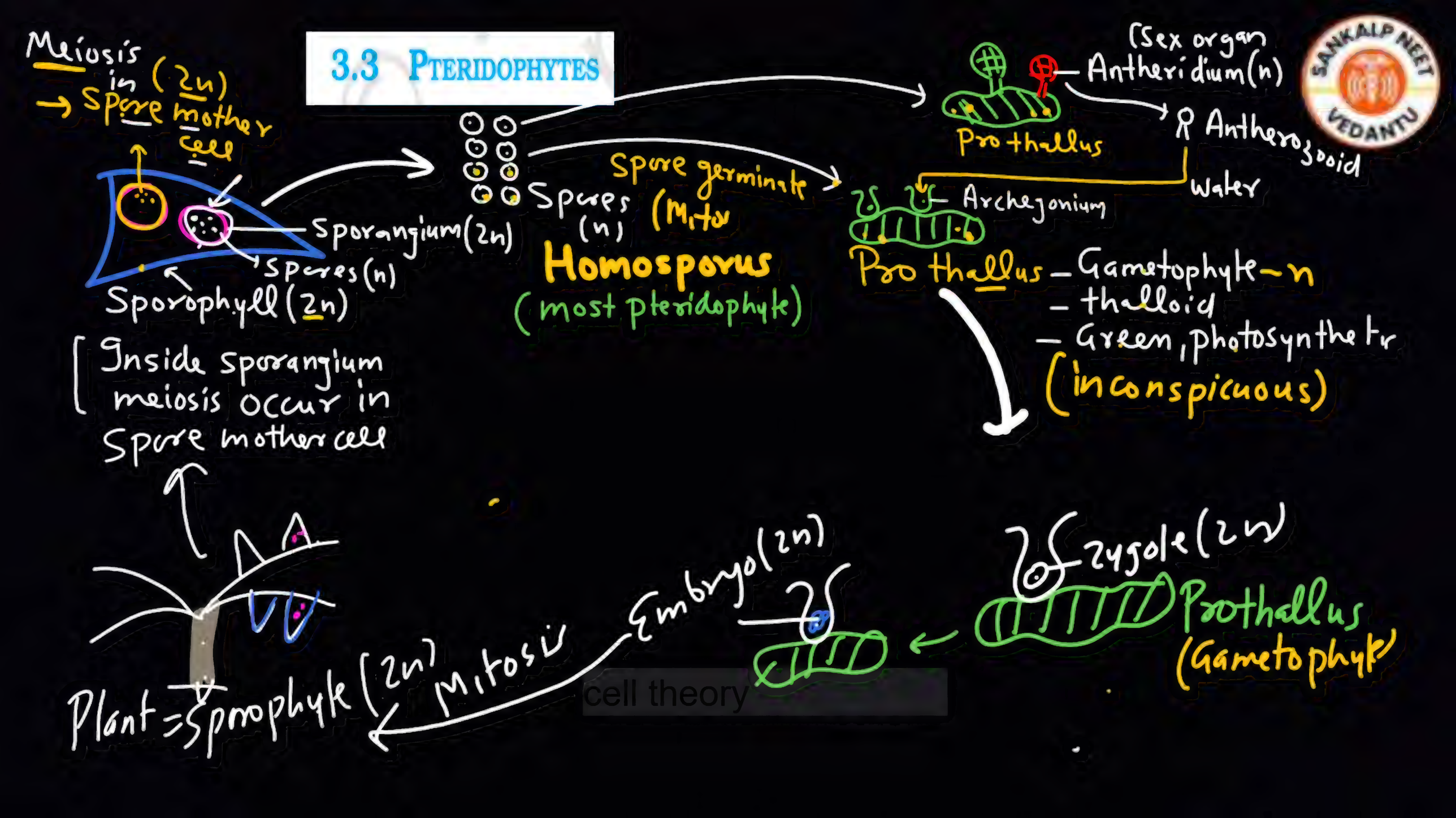
(Salvinia, Pteris, Dryopteris, Adiantum)





cell theory

3.3 Pteridophytes



3.3 Pteridophytes

- main plant | Dominant stage – Sporophyte ⟶ Special leaf – Sporophyll
- Meiosis occur inside Sporangium (occur in cell – Spore mother cell)
- Spore – Same size (Homosporus) ⟶ meaning → Spore not able to decide Whether to Form male gametophyte or Female gametophyte

– In pteridophyte – Both Gametophyte (Green) and sporophyte (Short lived, Green) is Free living

But Dominant stage is ⟶ Sporophyte (Long lived)

Bryophyte

main plant – Gametophyte

Sporophyte → Non-Green – dependent

Gametophyte – Green, Free living

Pteridophyte

- main plant – Sporophyte
- Sporophyte – Green, photosynthetic, Differentiated into Root, Stem, Leaf
- Gametophyte – Free living, Short lived, Small

cell theory

3.3 PTERIDOPHYTES

Pteridophyte → two type → ① Homosporus → male gametophyte / Female gametophyte

Same Size (n)

② Heterosporus → (Few pteridophyte)

Ex - Selaginella
- Salvinia

Microspore → Male gametophyte

(Macrospore) Megaspore → Female gametophyte (dependent)

note - Algae is Homosporus
Bryophyte is Homosporus
Pteridophyte - mostly - Homosporus

- Few pteridophyte
- Gymnosperm
- Angiosperm

] Salvinia, Selaginella = Heterosporus

cell theory

3.3 Pteridophytes

* What is seed → Seed(sperm) present in Gymnosperm & Angiosperm

Seed is → Structure → In which Next Generation Sporophyte (Embryo)

- Hard seed Coat
- Embryo (2n) (Next generation Sporophyte

Seed develop from Megasporangium

Requirement to make seed

- Microsporangium
- Megasporangium
  - Integument
- Megaspore (n)
- Megasporangium (2n)
  - Female gametophyte (dependent)
- Zygote
- Seed
  - Seed Coat
  - Embryo

cell theory

3.3 Pteridophytes

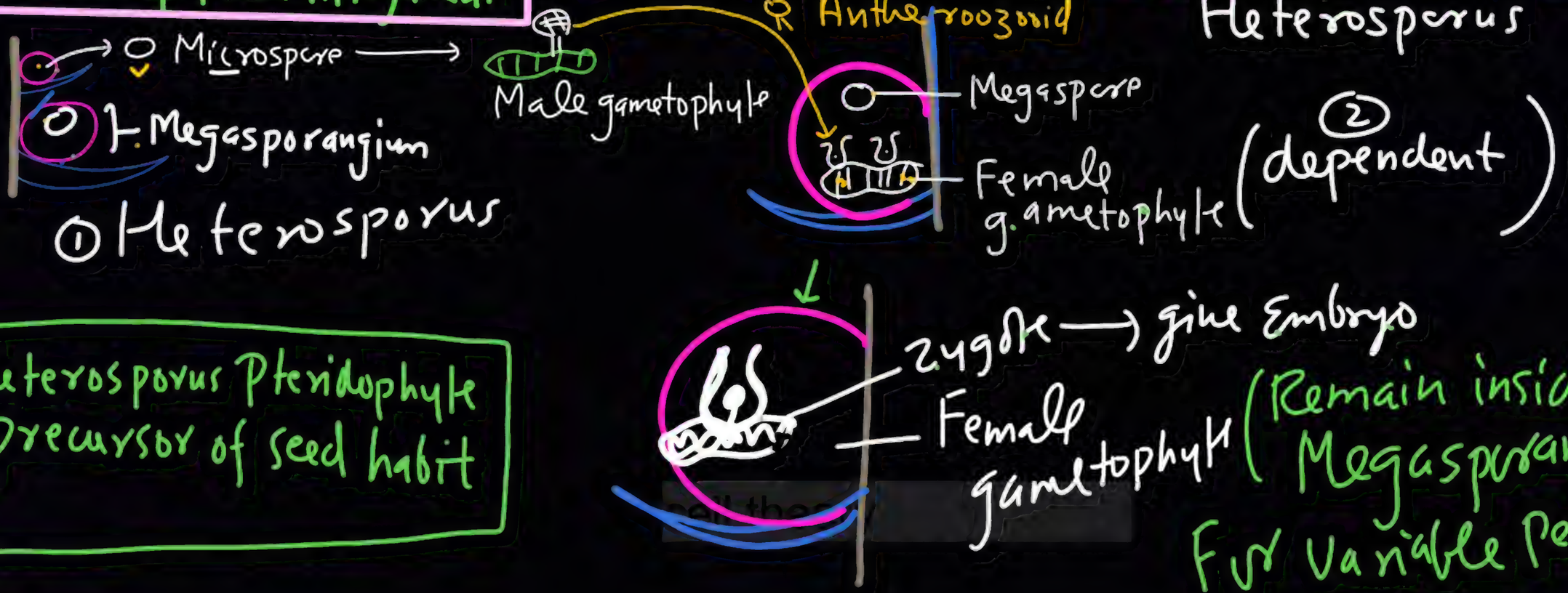
– Seed Formation – 4 Requirement

(a) Heterosporus → Megasporangium produce Megaspore

(b) Female gametophyte dependent on megaSporangium (sporophyte generation)

③ Hard seed coat develop From integument

④ Embryo Remain inside seed (Resting stage)



① Heterosporus

Heterosporus (②dependent)

Heterosporus Pteridophyte Precursor of seed habit

zygote → give Embryo

Female gametophyte (Remain inside Megasporangium For Variable Period)

3.3 PTERIDOPHYTES

Q Precursor of seed habit
(a) Most Pteridophyte (b) Few Pteridophyte

which is the dominant phase of the pteridophytes. In majority of the pteridophytes all the spores are of similar kinds; such plants are called **homosporous**. Genera like *Selaginella* and *Salvinia* which produce two kinds of spores, macro (large) and micro (small) spores, are known as **heterosporous**. The megaspores and microspores germinate and give rise to female and male gametophytes, respectively. The female gametophytes in these plants are retained on the parent sporophytes for variable periods. The development of the zygotes into young embryos take place within the female gametophytes. This event is a precursor to the **seed habit** considered an important step in evolution.

Q Seed habit present
(a) Gymno
(b) Angio

3.3 PTERIDOPHYTES

The pteridophytes are further classified into four classes: Psilopsida *(Psilotum)*; Lycopsida *(Selaginella, Lycopodium)*, Sphenopsida *(Equisetum)* and Pteropsida *(Dryopteris, Pteris, Adiantum)*.

Pteridophyte 4 Classes

(a) Psilopsida → Ex- Psilotum

(b) Lycopsida → Ex- Lycopodium, Selaginella

(c) Sphenopsida → Equisetum (Horse tail)

(d) Pteropsida (Fern) → Pteris, Dryopteris, Adiantum, Salvinia

cell theory

Questions

Q1 Homosporous condition present in (Alg, Bry, most)

(a) Pinus (Gym) (b) ~~Marchantia~~ (c) Neem (Ang) (d) Salvinia (Mal)

Q2 Dependent Female gametophyte present in [Heterosporous, Gym, Angio]

(a) Spirogyra Alg (b) Moss Bry (c) Selaginella (d) Sphagnum Bry

Q3 Antherozooid present in → Alg, Bry, Pte

(a) Funaria Moss (b) Pteris Pte (c) Marchantia ~~dually~~

Q4 Seed habit present in

(a) Grass (Monocot) (b) Gelidium (c) Selaginella (d) Both a & c ✗

Angiosperm

cell theory

Q Few Ex- are Given

Ulothrix (Alg), Marchantia (Bry), Funaria (Bry), Salvinia (Pt-H), Selaginella (Pt-H)

Cycas (Gym), Cedrus (Gym), Rose (Ang), Wheat (Ang), Pteris (Pt)

3, 6, 4, 2

Q How many

(a) haploid plant — Alg + Bry = 3

(b) Heterosporous → Pte-2 + 2 + 2 = 6

(c) Seed present → Gym + Angi = 4

(d) dependent, Multicellular → Bryo = 2

Sporophyte

Q Diploid plant - Pte, Gym, Ang = 3 + 2 + 2 = 7

DOPA-

Q S-I Number of cell in Sporophyte of Fucus is less than spirogyra
S-II least number of cells present in Gametophyte of Angiosperm

Q S-I Precursor of seed habit Are Homosporus Pteridophyte
S-II Precursor of seed have are Heterosperus Pteridophyte

Q S-I Prothallus is short lived & Green
S-II Dependent male & Female gametophyte present in most Pteridophyte

Q S-I Haplodiplontic life cycle present in Selaginella
S-II Salvinia and Pinus are Heterosporus

Q S-I Sphagnum are Moss and Homospore
S-II Flowers containing plants are Homosporus

(a) Only S-I Correct (b) Only S-II Correct (c) Both S-I & S-II Correct (d) Both wrong

MANTHAN NEET 2025 -

Plant kingdom

lecture - 7

Botany

TARUN SIR

Topics

- Algae
- Bryophyte
- pteridophyte
- Gymnosperm
- Angiosperm

2 no of Question + 3 → 12 Marks

Today's Goal

Basics of Algae

cell theory

Important Examples

Green Algae — Chlamydomonas, Chlorella, Spirogyra, ulothrix, Chara, Cladophora, Voluox, Eudorina

Brown Algae – Ectocarpus, Kelp, Laminaria, Sargassum, Fucus, Dictyota

Red Algae — Polysiphonia, Gelidium, Gracilaria, Porphyra

Phycoerythrin – (Red Algae)

Q1 Phycoerythrin present in
(a) Voluox (b) Ulothrix (c) Fucus (d) Gelidium

cell theory

II

Bryophytes

- Liverworts → Marchantia ←
- Moss → Sphagnum, Polytrichum, Funaria

III

Pteridophytes

Fern

1. Psilopsida → - Psilotum ✓
2. Pteropsida - Pteris, Dryopteris, Adiantum, Azolla, Salvinia
3. Sphenopsida - Equisetum (Horse tail)
4. Lycopsida - Selaginella, Lycopodium

IV

Gymnosperm →

Conifers - Pinus, Cedrus
- Cycas
- Sequoia, Ginkgo
(tallest tree)

Pteridophyte

Most common → Horse tail (Equisetum) & Ferns

Use → Ornamental & Medicinal & Some soil Binder (Prevent Soil Erosion)

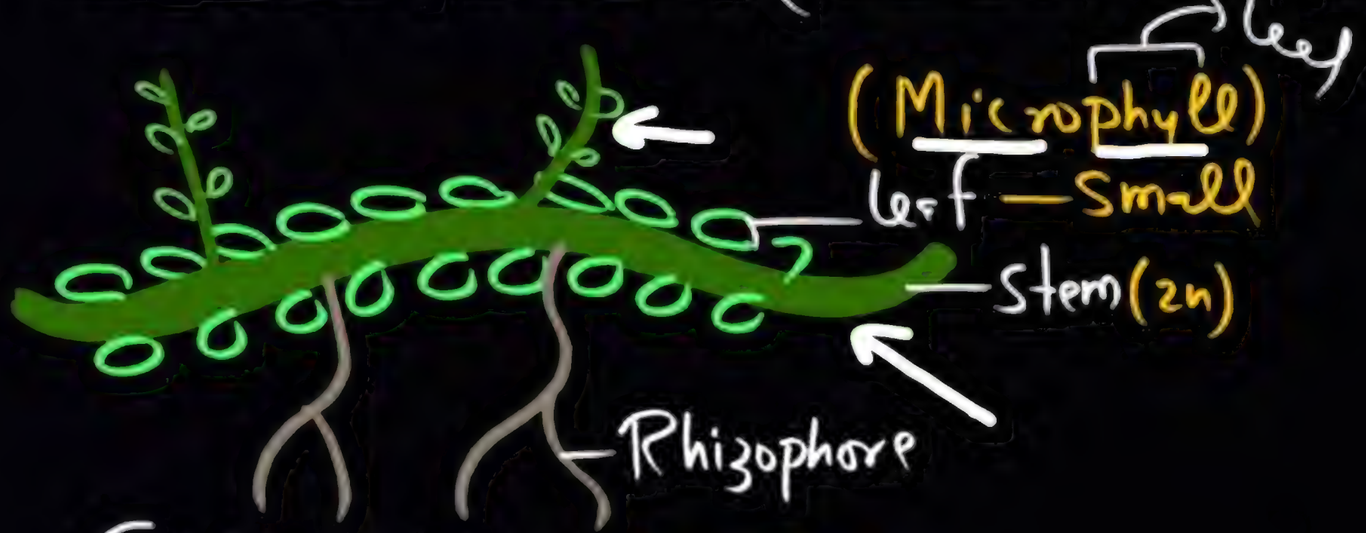
Habitat ⟶ Cold & Shady Place, Some Grow in Sandy soil

Important points
- Algae & Bryophyte – haploid plant – main plant Body – Gametophyte
- Pteridophyte – Diploid plant – Dominant plant Body – Sporophyte
- Pteridophyte First terrestial with vascular Bundle → Xylem & Phloem

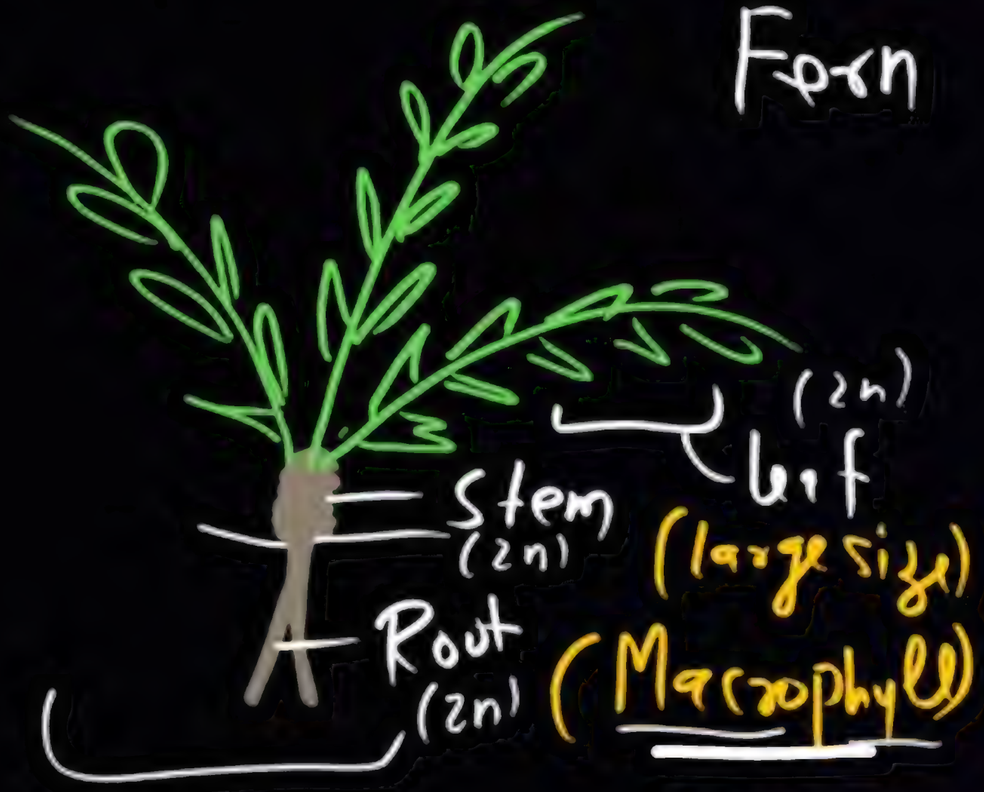
Q Vascular Bundle present in
(a) Porphyra (Alg) (b) ~~Pteris~~ (c) Marchantia (Bry) (d) Sphagnum (Bry)

Structure of Pteridophyte

- Main plant Body - Sporophyte
- True Root, Stem & Leaf (vascular tissue present)



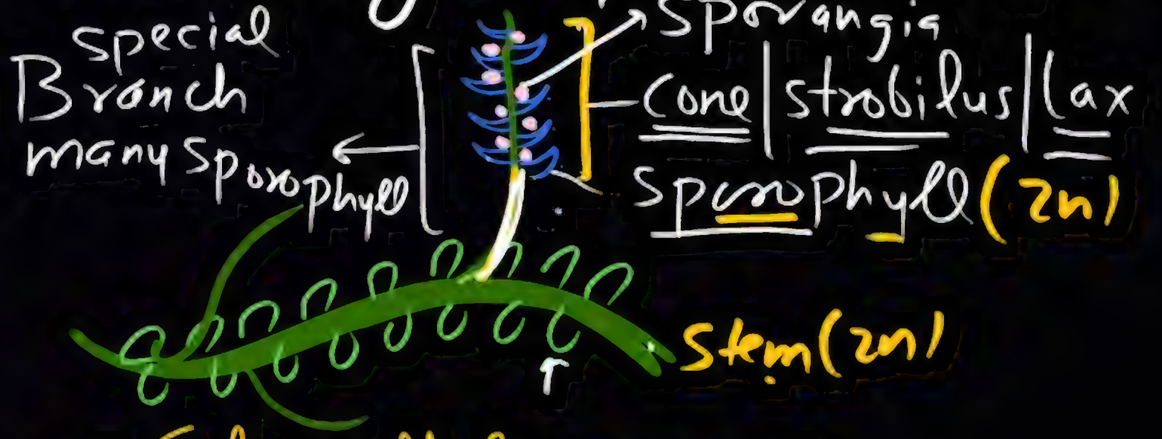
Selaginella - Sporophyte



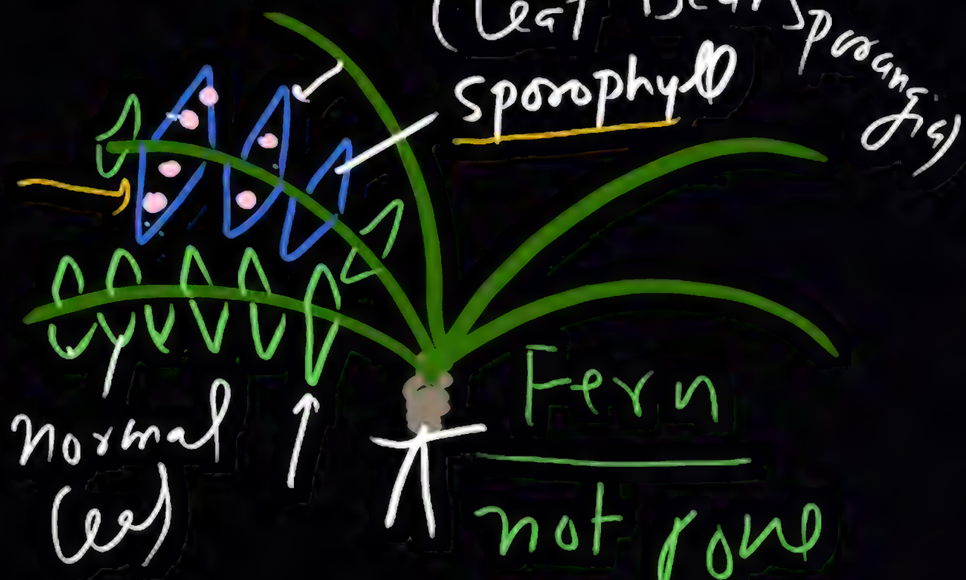
About pteridophyte – main plant Body – Sporophyte – Diploid
– Vascular Bundle – First time

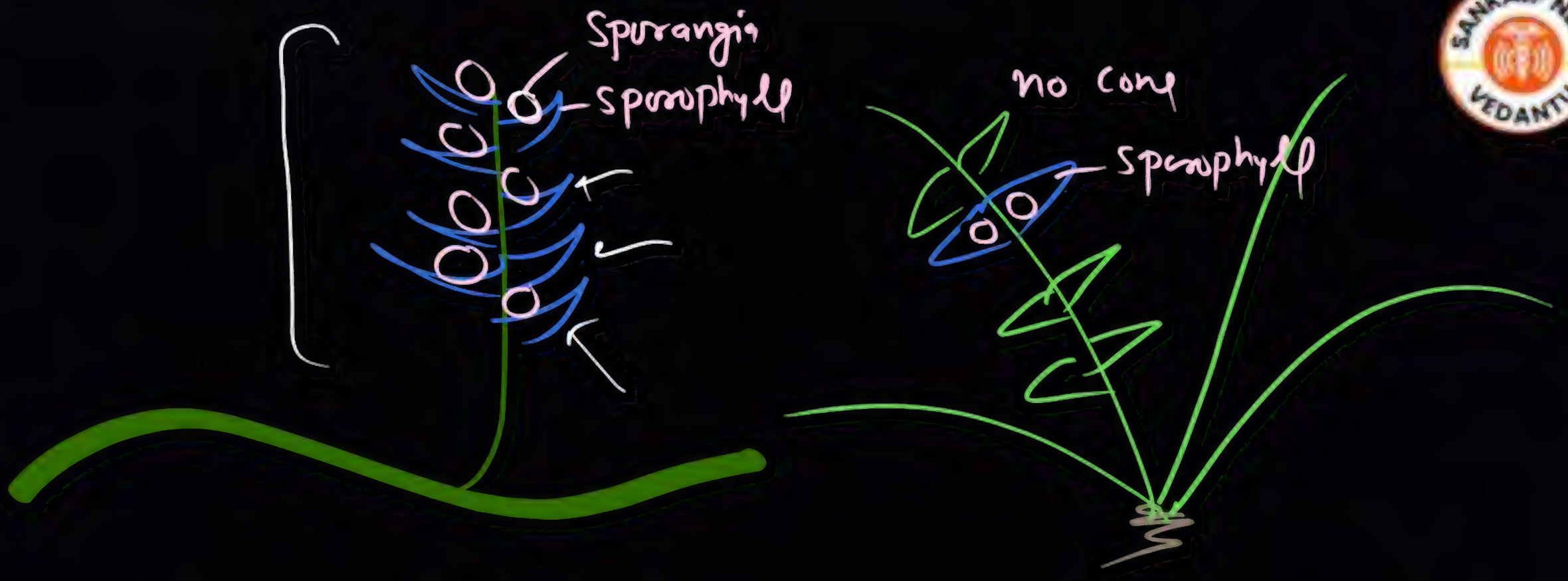
Spores produced in
– In Algae ⟶ Zygotic meiosis
– In Bryophyte ⟶ Inside capsule

→ In pteridophytes ⟶ Spores produced inside ⟶ Sporangium (singular) – 2n
→ Sporangium present on special leaf ⟶ Sporophyll



→ Selaginella } Sporangia
→ Equisetum } Present in cone

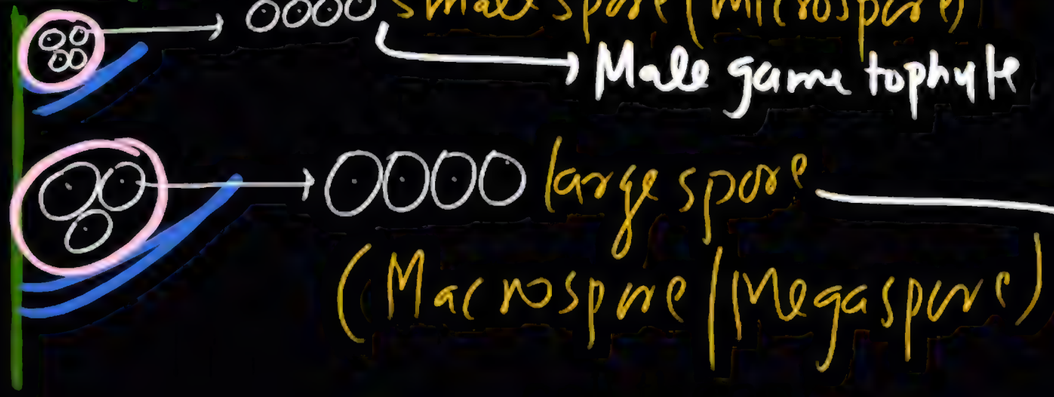



Sporangia
Sporophyll
no cone
Sporophyll

Two type of Pteridophyte

Homosporus – Spores Form inside sporangium ∈ all spores Same size → Homosporus [Most pteridophyte

Heterosporous (Some Pteridophytes → Selaginella, Salvinia] Genus



How Spores Vary in Plant Kingdom

Algae → Zygote —Meiosis→ ○○○○ Same size

Bryophyte → Capsule —Meiosis→ ○○○○ Same size (Any spore male gametophyte other Female gametophyte

Pteridophyte → Sporangium —Meiosis→ ○○○○ Spore (Same size) [Most pteriophyte

Small sporangium —Meiosis→ ○○○○ → Male gametophyte

large sporangium —Meiosis→ ○○○○ → Female Gametophyte

Heterospores

Gymosperm → Small sporangium
→ large sporangium

Angiosperm → ♀ small sporangium
→ ♂ large sporangium

Q Which is Homosporus

(a) Pinus (b) Selaginella (c) Neem (d) Lycopodium (Homo)

Pt

Gym — Exception — Ang

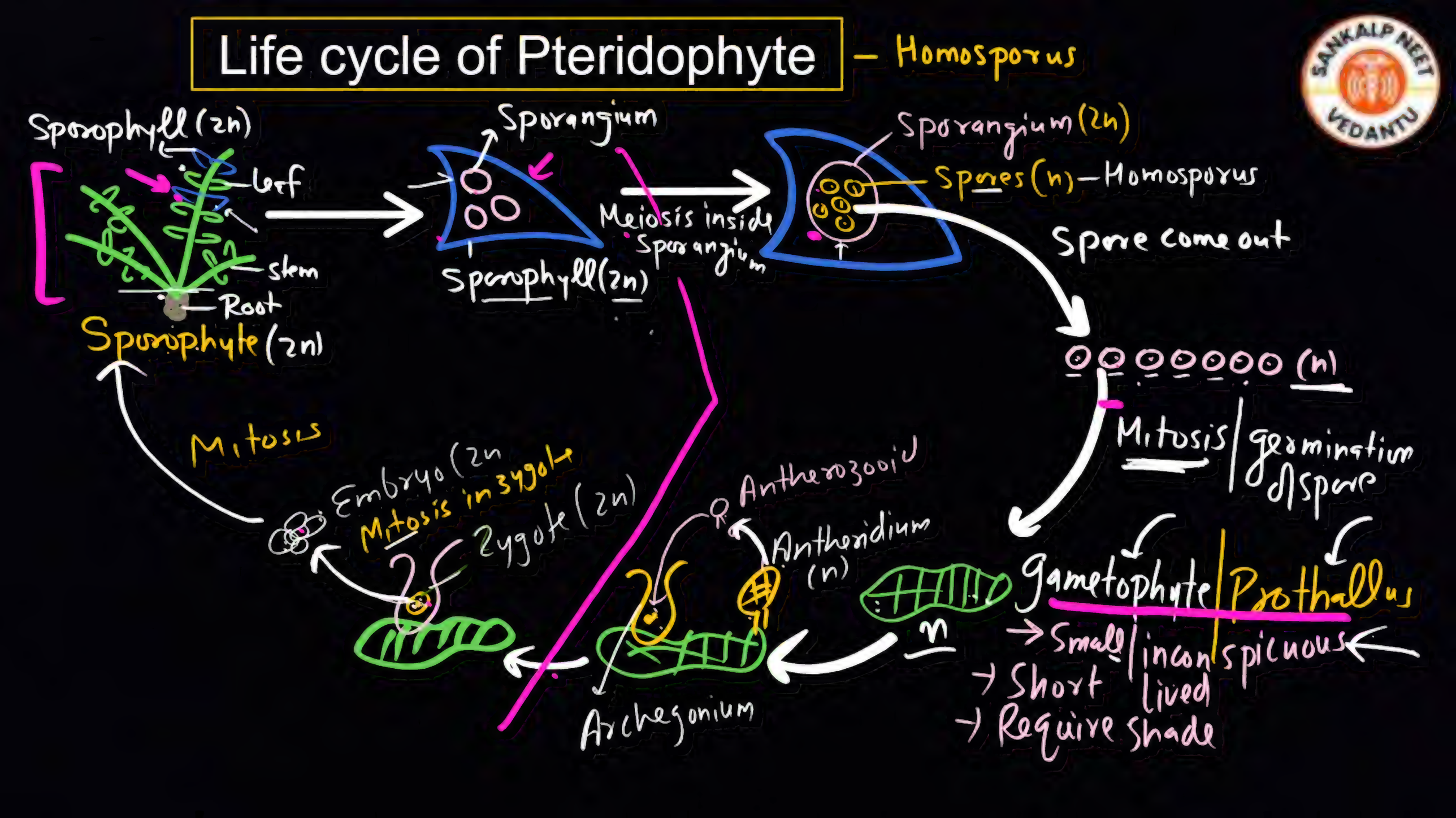
Homo

(Q S-I Algae are Homosporus

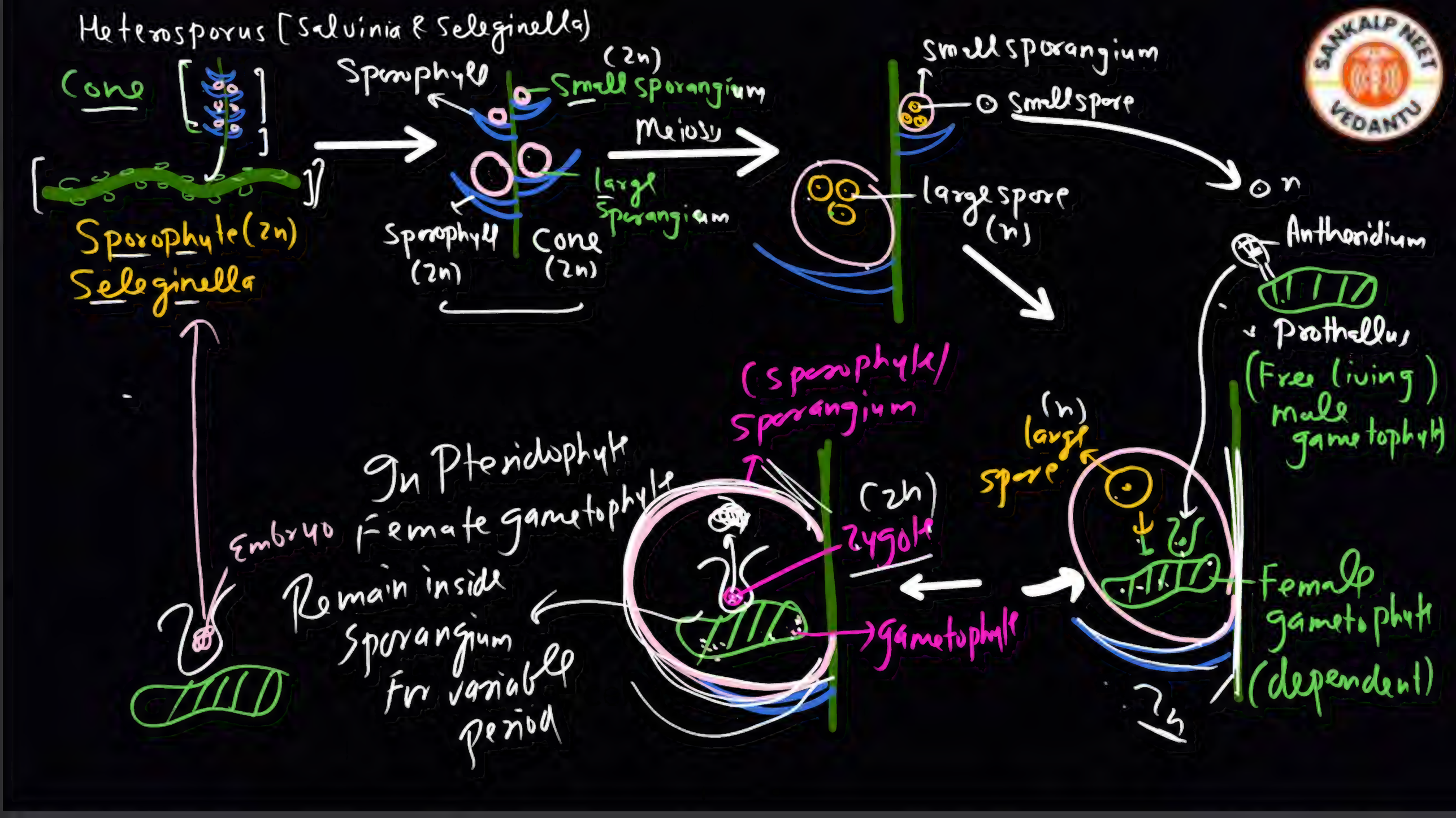
S-II In Bryophyte same size spores produce in Capsule

Both

Life cycle of Pteridophyte – Homosporus



- Pteridophyte → main plant Body → Sporophyte
  - → Life cycle – Haplodiplontic
  - → Sporophyll, sporangium → Diploid
  - → Inside sporangium → Meiosis occur to give haploid spore (same size)
  - → Spore(n) germination (Mitosis) give gametophyte
- Pteridophyte – gametophyte (Prothallus) & sporophyte Both Free Living
  Both Green photosynthetic
- Since Prothallus – Require shade & Fertilization Require water
  So, Distribution limited


Heterosporus [Salvinia & Selaginella]
Cone
Sporophyte (2n)
Selaginella
Sporophyll
Small sporangium
(2n)
Meiosis
large Sporangium
Sporophyll (2n)
Cone (2n)
small sporangium
small spore
large spore (n)
n
Antheridium
Prothallus
(Free living) male gametophyte
(sporophyte/ sporangium
(2n)
Zygote
Embryo
In Pteridophyte female gametophyte
Remain inside Sporangium for variable period
gametophyte
(n)
large spore
Female gametophyte (dependent)
2n

Seed habit – Seed present → Gn Gymnosperm, Angiosperm → Spermatophyta (Seed)

Heterosporus Pteridophyte → Precursor of seed habit – Preperation of seed habit

SEED → Four Requirement

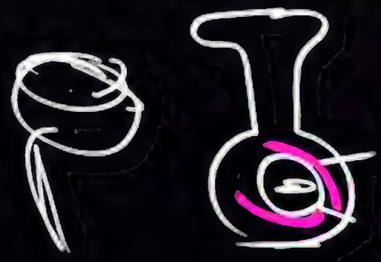
(a) Heterosporus

(b) Female gametophyte depend on sporophyte — next generation Zygote/Embryo Remain inside Sporangium

(c) Hard integument – Around Sporangium

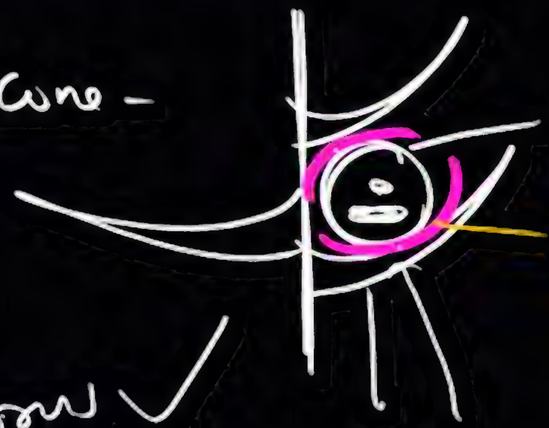
(d) Embryo undergo Resting Stage

Heterosporus Pteridophyte – First two Requirement completed not last two — Preperation occur For seed But seed not develop



(ovule) Megasporangium ⟶ Seed

Gymnosperm – Cone –



Megasporangium ⟶ Seed

Integument – Seed

① Heterosporous ✓

② FG – dependent ✓

Sporophyte (2n) → Cone (2n)

Cone (2n) → Small sporangium (2n) → Small Spore (n) → Male gametophyte (n)

Cone (2n) → large sporangium (2n) → large Spore (n) → Female gametophyte (dependent) (Inside)

Male gametophyte → Antherozoid → Female gametophyte

cell theory

Life cycle of Pteridophyte

SANKALP NEET VEDANTU

cell theory

Q1 Which is haploid

(a) leaf of moss (b) leaf of Fern

Q2 Sporophyte is Green in

(a) Marchantia (b) Sphagnum (c) Horsetail (d) alp

Q3 Meiosis occur. in all Except

(a) Zygote in Algae (b) Capsule in Moss

(c) Capsule in liverwort (d) all

cell theory

You may recall that in bryophytes the dominant phase in the life cycle is the gametophytic plant body. However, in pteridophytes, the main plant body is a sporophyte which is differentiated into true root, stem and leaves (Figure 3.3). These organs possess well-differentiated vascular tissues. The leaves in pteridophyta are small (microphylls) as in *Selaginella* or large (macrophylls) as in ferns. The sporophytes bear sporangia that are subtended by leaf-like appendages called **sporophylls**. In some cases sporophylls may form distinct compact structures called strobili or cones (*Selaginella*, *Equisetum*). The sporangia produce spores by meiosis in spore mother cells. The spores

free-living, mostly photosynthetic thalloid gametophytes called **prothallus**. These gametophytes require cool, damp, shady places to grow. Because of this specific restricted requirement and the need for water for fertilisation, the spread of living pteridophytes is limited and restricted to narrow geographical regions. The gametophytes bear male and female sex organs called antheridia and archegonia, respectively. Water is required for transfer of antherozoids – the male gametes released from the antheridia, to the mouth of archegonium. Fusion of male gamete with the egg present in the archegonium result in the formation of zygote. Zygote thereafter produces a multicellular well-differentiated sporophyte which is the dominant phase of the pteridophytes. In majority of the pteridophytes all the spores are of similar kinds; such plants are called **homosporous**. Genera like *Selaginella* and *Salvinia* which produce two kinds of spores, macro (large) and micro (small) spores, are known as **heterosporous**. The megaspores and microspores germinate and give rise to female and male gametophytes, respectively. The female gametophytes in these plants are retained on the parent sporophytes for variable periods. The development of the zygotes into young embryos take place within the female gametophytes. This event is a precursor to the **seed habit** considered an important step in evolution.

The pteridophytes are further classified into four classes: Psilopsida *(Psilotum)*; Lycopsida *(Selaginella, Lycopodium)*, Sphenopsida *(Equisetum)* and Pteropsida *(Dryopteris, Pteris, Adiantum)*.

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cell theory

cell theory

cell theory

3.3 PTERIDOPHYTES

The Pteridophytes include horsetails and ferns. Pteridophytes are used for medicinal purposes and as soil-binders. They are also frequently grown as ornamentals. Evolutionarily, they are the first terrestrial plants to possess vascular tissues - xylem and phloem. You shall study more about these tissues in Chapter 6. The pteridophytes are found in cool, damp, shady places though some may flourish well in sandy-soil conditions.

Q1 Which is haploid

(a) leaf of moss (b) leaf of Fern → Pte

n → G ← Bryo

n → S ← main plant

Q2 Sporophyte is Green in

(a) Marchantia (b) Sphagnum (c) Horsetail (d) alp

Bry Bry Pte

Q3 Meiosis occurs in →

(a) Zygote in Algae (b) Capsule in Moss

(c) Capsule in liverwort (d) all

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living world

lecture –01

Botany

TARUN SIR

Topic

1. Nomenclature
2. Taxonomic category

Deleted topics → Feature of living
- taxonomic AIDS

How wonderful is the living world ! The wide range of living types is amazing. The extraordinary habitats in which we find living organisms, be it cold mountains, deciduous forests, oceans, fresh water lakes, deserts or hot springs, leave us speechless. The beauty of a galloping horse, of the migrating birds, the valley of flowers or the attacking shark evokes awe and a deep sense of wonder. The ecological conflict and cooperation among members of a population and among populations of a community or even the molecular traffic inside a cell make us deeply reflect on – what indeed is life? This question has two implicit questions within it. The first is a technical one and seeks answer to what living is as opposed to the non-living, and the second is a philosophical one, and seeks answer to what the purpose of life is. As scientists, we shall not attempt answering the second question. We will try to reflect on – what is living?

Living world

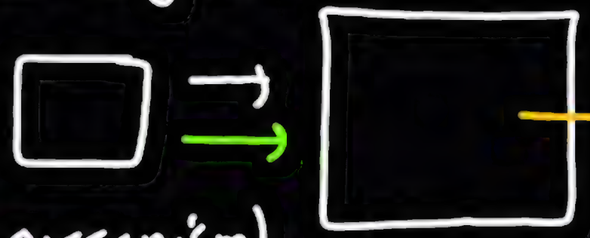
Around us → ① Different type of Habitat (Forest, mountain) ✓
② Different type of Organism ✓
③ Different type of interaction (Predation, competition

What is living → Techical → Living have some Feature (Growth, Reproduction, Metabolism)
Which non-living not have

Philosphical view – Why we are Living →

Diversity in living organism

→ When we observe → Different type of insect, plants and Animal we can observe, Some Micro organism is not visible

→ As we increase Area →  → More no. of species present

(dense Forest – more organism)

Biodiversity – Diversity in Living organism

Different type Species constitute Biodiversity →

1.7 to 1.8 million species → Discovered & named

– large no. of species Yet to be Discovered – So we need some Science to Group (Classify) & name new species

1.2 Diversity in the Living World

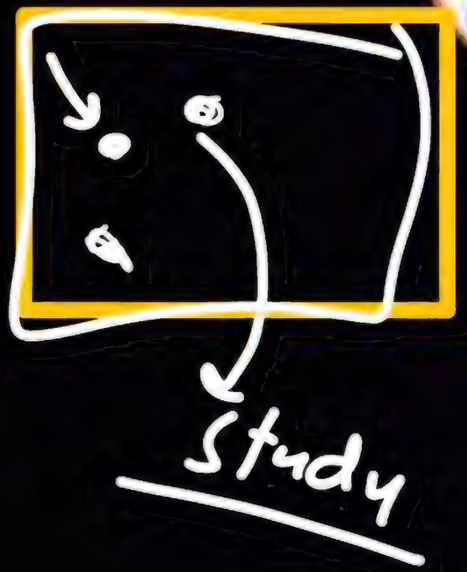
If you look around you will see a large variety of living organisms, be it potted plants, insects, birds, [illegible] or other animals and plants. There are also several organisms that you cannot see with your naked eye but they are all around you. If you were to increase the area that you make observations in, the range and variety of organisms that you see would increase. Obviously, if you were to visit a dense forest, you would probably see a much greater number and kinds of living organisms in it. Each different kind of plant, animal or organism that you see, represents a species. The number of species that are known and described range between 1.7-1.8 million. This refers to **biodiversity** or the number and types of organisms present on earth. We should remember here that as we explore new areas, and even old ones, new organisms are continuously being identified.

what is classification

→ It is not possible to study Every Organism

→ We need to Group organism into common category ✓
On the Basis of Easily observable character

[Classificatim is Grouping of organism into common category]



Since it is nearly impossible to study all the living organisms it is necessary to devise some means to make this possible. This process is **classification**. Classification is the process by which anything is grouped into convenient categories based on some easily observable characters. For example, we easily recognise groups such as plants or animals or dogs, cats or insects. The moment we use any of these terms, we associate certain characters with the organism in that group. What image do you see when you think of a dog ? Obviously, each one of us will see 'dogs' and not 'cats'. Now, if we were to think of 'Alsatians' we know what we are

taxa and category

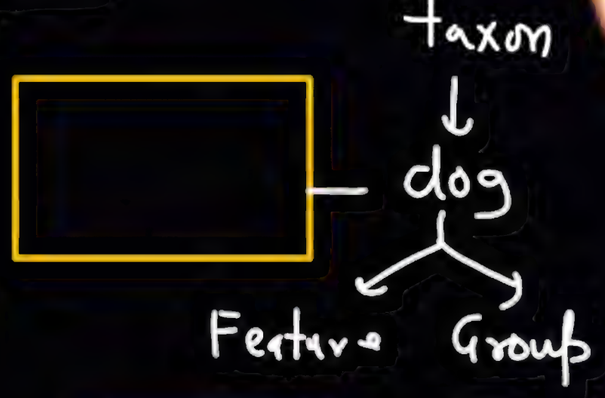
[Single-taxon ←
many-taxa ←]

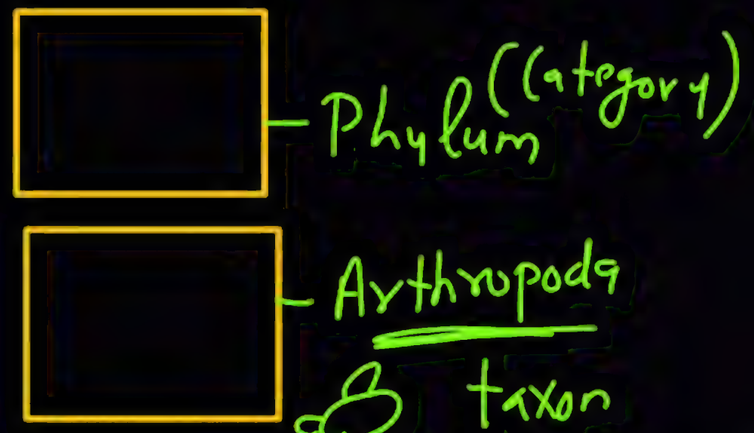
Category → Simple Group is Category ←

taxon → it is that Category, Some name associated Feature is associated ✓

Ex- dog, Cat, Alsitian, Ascomycetes, Monera

[→ taxon is Scientific term for category]





Other Example of Category - Genus, Kingdom

Taxon - Monera, Archabacteria
Mycoplasma, Ustilago

Q Find taxon at Same level
(a) Monera & E.coli (b) Agarikus & Ust.lago (c) Protista & Amoeba (d) Animalia & Earthworm

talking about. Similarly, suppose we were to say 'mammals' you would, of course, think of animals with external ears and body hair. Likewise, in plants, if we try to talk of 'Wheat', the picture in each of our minds will be of wheat plants, not of rice or any other plant. Hence, all these - 'Dogs', 'Cats', 'Mammals', 'Wheat', 'Rice', 'Plants', 'Animals', etc., are convenient categories we use to study organisms. The scientific term for these categories is **taxa**. Here you must recognise that taxa can indicate categories at very different levels. 'Plants' – also form a taxa. 'Wheat' is also a taxa. Similarly, 'animals', 'mammals', 'dogs' are all taxa – but you know that a dog is a mammal and mammals are animals. Therefore, 'animals', 'mammals' and 'dogs' represent taxa at different levels.

What is taxonomy

branch which deals with process of classification of Any organism into taxon

→ taxonomy Require knowledge of Features — cell structure - nutrition

(Many details like → Ecological information, Internal structure) → Modern taxonomy studies

Steps in taxonomy

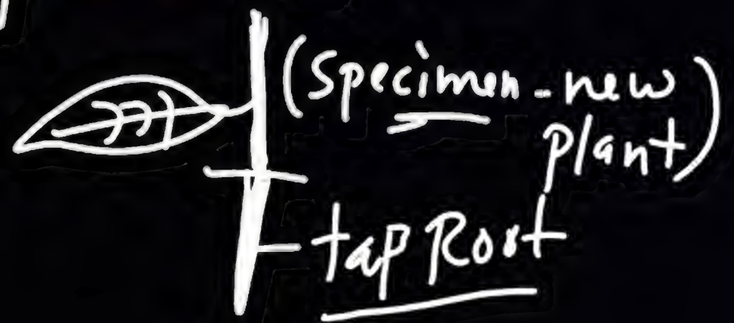
(a) Description → Characterisation - Correctly describe

(b) Identification → By using Already discover specimen

(c) Classification - Place in suitable category

(d) Nomenclature - Providing name

Fungi



Hence, based on characteristics, all living organisms can be classified into different taxa. This process of classification is **taxonomy**. External and internal structure, along with the structure of cell, development process and ecological information of organisms are essential and form the basis of modern taxonomic studies.

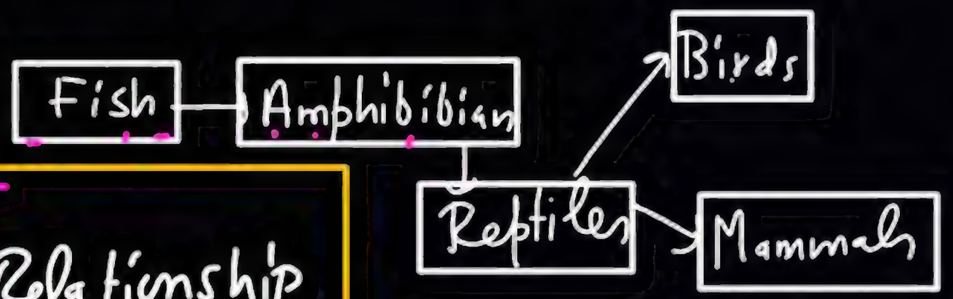
Hence, characterisation, identification, classification and nomenclature are the processes that are basic to taxonomy.

Taxonomy is not something new. Human beings have always been interested in knowing more and more about the various kinds of organisms, particularly with reference to their own use. In early days, human beings needed to find sources for their basic needs of food, clothing and shelter. Hence, the earliest classifications were based on the 'uses' of various organisms.

- Human perform taxonomy → Since old time - on the Basis of need

Systematics → not only interested to place new organism into correct taxon But also Find Relationship Blw them

Systematic | proper arrangement of taxon on the Basis of Relationship



Systematics = taxonomy + Evolutionary Relationship (Phylogenetic Relationship

term use By - Carolus Linnaeus [Book - Systema naturae]

Human beings were, since long, not only interested in knowing more about different kinds of organisms and their diversities, but also the relationships among them. This branch of study was referred to as **systematics**. The word systematics is derived from the Latin word 'systema' which means systematic arrangement of organisms. Linnaeus used *Systema Naturae* as the title of his publication. The scope of systematics was later enlarged to include identification, nomenclature and classification. Systematics takes into account evolutionary relationships between organisms.

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living world

lecture – 02

Botany

TARUN SIR

Topic

1. Nomenclature ✓
2. Taxonomic category ✓

Deleted topics → Feature of living
- taxonomic AIDS

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Classification

not Able to study → Every organism → we need to classify they → on the Basis of Feature

Category → Group

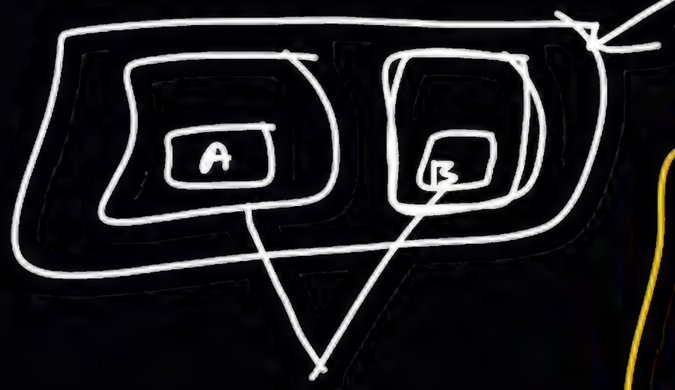
taxon → Feature associate

Cat
Dog
Mamma
Birds
Fish
— taxon

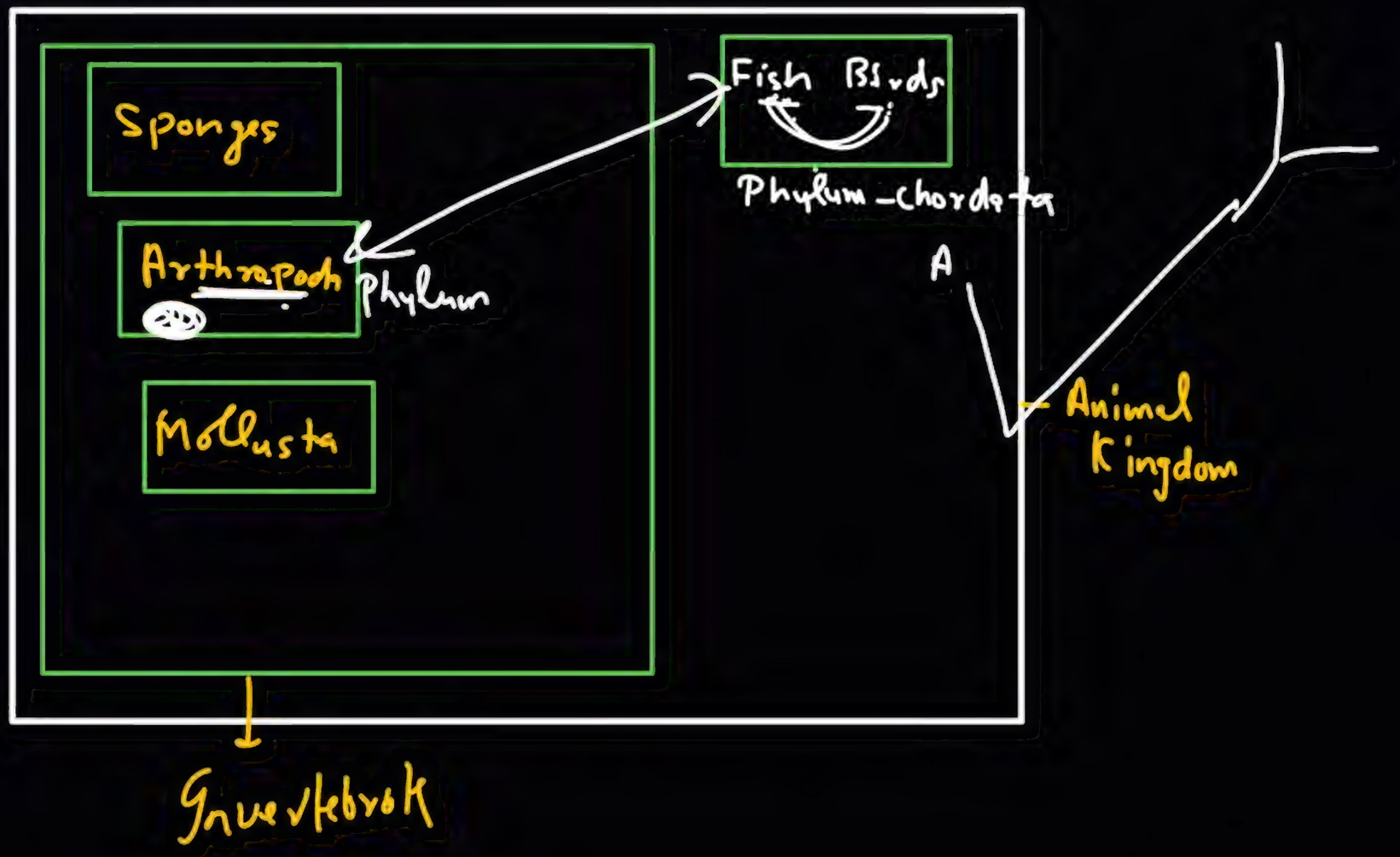
Taxonomy →

Power

Kingdom



↓ Characterization
Identification
classification
→ Nomenclature


Sponges
Arthropoda
Phylum
Mollusta
Fish
Birds
Phylum - Chordata
A
- Animal Kingdom
Invertebrate

steps in taxonomy

- taxonomy is a process By which Any organism is Grouped into Suitable taxon

Plant specimen

(a) Characterization / descriptions

(b) Identification → [With the help of Already Discovered Specimen → Taxonomic AIDS]

(c) Classification → Group / Classify new specimen in Proper taxon

(d) Nomenclature – Providing Correct Name

Nomenclature

- With time large no. of organism will be Discovered
- We need to standardise name of new specimen (plant/Animal) — Nomenclature

Two type of name:- (a) local name (b) Scientific name

I local name ⟶ It is name given to specimen in particular Region

Problem:- This name ⟶ change with Region/language

(a) Same specimen ⟶ More than one name — which create confusion

(b) Same name can be of two Different specimen

Scientific name | taxonomic name | Biological name

- name provided According to some general principle / Rules
- These Rules are Acceptable to all taxonomist
- For one specimen ⟶ in two Different Region ⟶ if we Follow same Rule ⟶ then we come on **common name**

Example → Scientist A ⟶ Rules develop ⟶ 2000 names
Scientist-B ⟶ Rules develop ⟶ 2200 name ⟶ This is Accepted
Scientist-C ⟶ Rules develop ⟶ 2500

Rule Accept to Give name
all name Accepted

* First time → Rules Accepted was of — Carolus Linnaeus

(Rules of Binomial nomenclature)

(Rules of other Scientist Rejected)

As stated earlier, there are millions of plants and animals in the world; we know the plants and animals in our own area by their local names. These local names would vary from place to place, even within a country. Probably you would recognise the confusion that would be created if we did not find ways and means to talk to each other to refer to organisms we are talking about.

Hence there is a need to standardise the naming of living organisms such that a particular organism is known by the same name all over the world. This process is called **nomenclature**. Obviously, nomenclature or naming is only possible when the organism is described correctly and we know to what organism the name is attached to. This is **identification**.

not Imp

1750 [Carolus linnaeus (Scientist)] → Rules Accept → Two Book Published → ① Species plantarum – plant Specimen name

② Systema naturae – Animal Specimen name

After 200 year (Approx)

1970s → Some change in Rules, Seperate code(Rule) develop For Plant & Animals

- ICBN – International code For Botanical Nomenclature
- ICZN → International code of Zoological Nomenclature

ICBacN – International Code For Bacterial Nomenclature

ICVN → International code For Viral nomenclature

ICNCP – International code For Nomenclature of Cultivated Plants

In order to facilitate the study, number of scientists have established procedures to assign a scientific name to each known organism. This is acceptable to biologists all over the world. For plants, scientific names are based on agreed principles and criteria, which are provided in International Code for Botanical Nomenclature (ICBN). You may ask, how are animals named? Animal taxonomists have evolved International Code of Zoological Nomenclature (ICZN). The scientific names ensure that each organism has only one name. Description of any organism should enable the people (in any part of the world) to arrive at the same name. They also ensure that such a name has not been used for any other known organism.

Biologists follow universally accepted principles to provide scientific names to known organisms. Each name has two components – the **Generic name** and the **specific epithet**. This system of providing a name with two components is called **Binomial nomenclature**. This naming system given by Carolus Linnaeus is being practised by biologists all over the world. This naming system using a two word format was found convenient. Let us take the example of mango to understand the way of

providing scientific names better. The scientific name of mango is written as *Mangifera indica*. Let us see how it is a binomial name. In this name *Mangifera* represents the genus while *indica* is a particular species, or a specific epithet. Other universal rules of nomenclature are as follows:

Rules for Bionomical nomenclature

(a) Every Scientific name → two part, First Genus & Second Species / Specific epithet

Mangifera indica
genus species / specific epithet

Apis indica – Species
indica – no meaning
Apis → Genus

Homo sapiens → Species
Homo → Genus
Sapiens → no meaning

Apis flavus
Apis indica

(b) Genus start with capital letter, Species start with small letter

(c) Scientific name is in latin language (dead language – no changes occuring)

Mangifera indica – Print in italics → to show their latin origin ✓

Manifera indica – underline seperately

1. Biological names are generally in Latin and written in italics. They are Latinised or derived from Latin irrespective of their origin.

Mango india ⟶ Mangifera indica

2. The first word in a biological name represents the genus while the second component denotes the specific epithet.

3. Both the words in a biological name, when handwritten, are separately underlined, or printed in italics to indicate their Latin origin.

4. The first word denoting the genus starts with a capital letter while the specific epithet starts with a small letter. It can be illustrated with the example of *Mangifera indica*.

⑤ Name of Author | Scientist which provided name ⟶ Written After Scientific name complete | Abbreviated (Short Form)

Mangifera indica (linn.) ✓ ⟶ not in italics

Apis indica linn. ✓

Triticum aestivum Benth.

Mangifera indica Linn.

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living world

lecture – 03

Botany

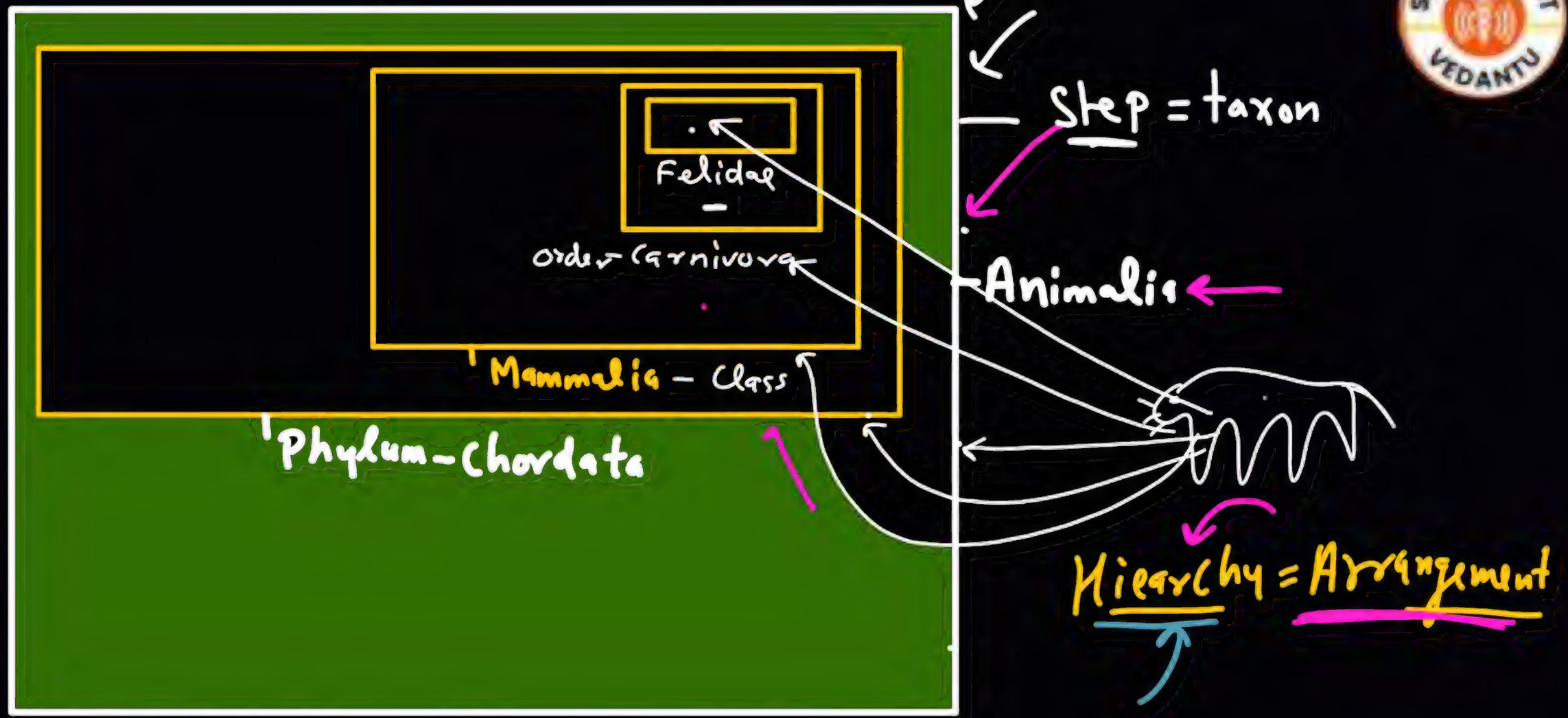
TARUN SIR

Topic

1. Nomenclature ✓
2. Taxonomic category ✓

Deleted topics → Feature of living
- taxonomic AIDS

cell theory


Step = taxon
Felidae
Order Carnivora
Mammalia – Class
Phylum-Chordata
Animalia
Hierarchy = Arrangement

Taxonomic category

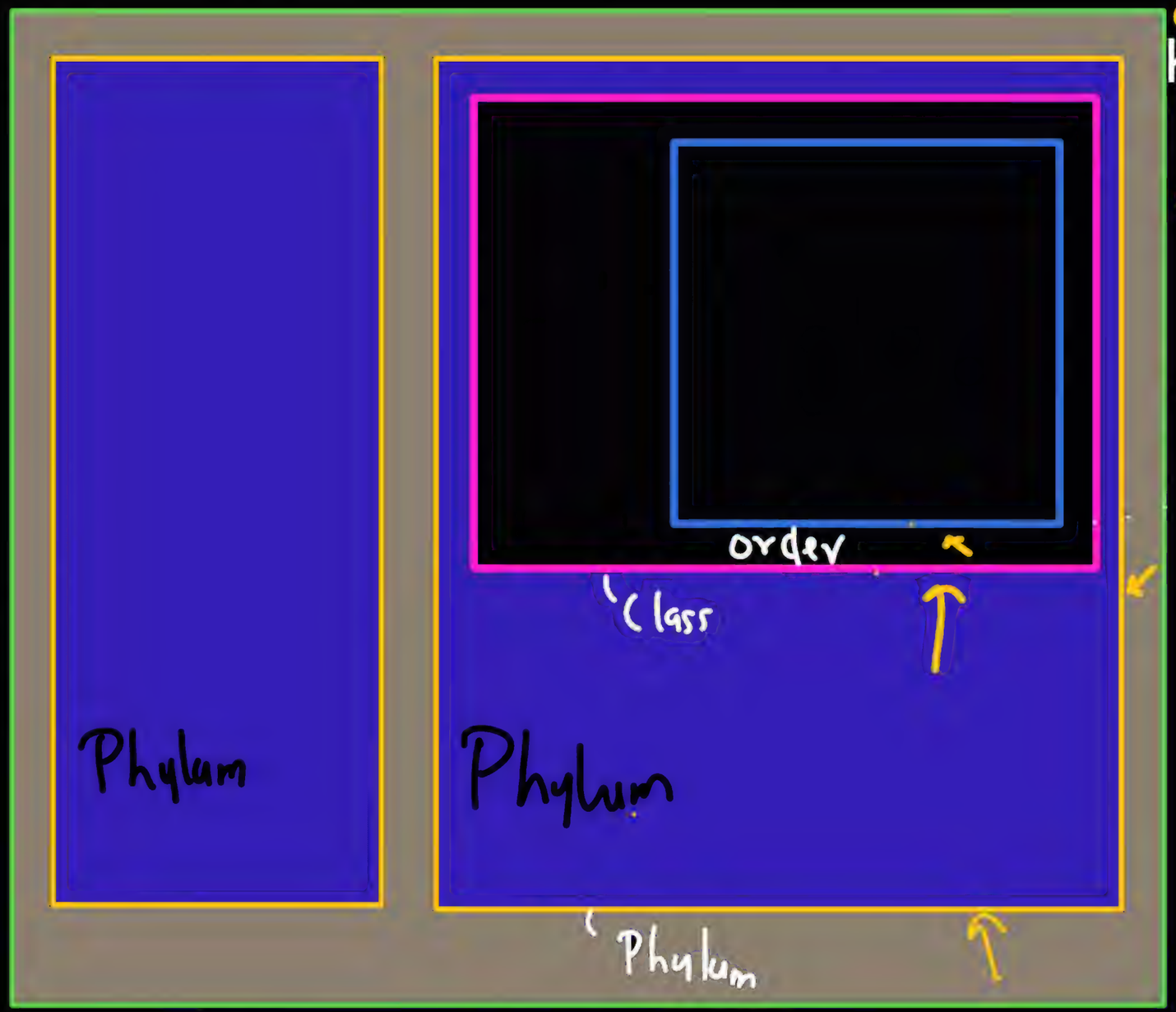
- Classification is not a Single step process → hieachy of step - we move step wise (Kingdom → Phylum → Genus → Species)

→ Each step (Kingdom, Phylum) = Taxon = taxonomic category = Rank in hieachy

→ All category together constitute → taxonomic hieachy

→ Each category → Unit of Classification

India
↓
UP → Kanpur
↓
Ramghat → Surya Society
↓
Flat-2A



Taxonomic hierarchy

Animalia ✓
↓
Chordata ✓
↓
Mammalia - Class
↓
Carnivora - Order
↓
Felidae - Family
↓
Panthera - Genus
↓
tigris :

1.3 Taxonomic Categories

Classification is not a single step process but involves hierarchy of steps in which each step represents a rank or category. Since the category is a part of overall taxonomic arrangement, it is called the **taxonomic category** and all categories together constitute the **taxonomic hierarchy**. Each category, referred to as a unit of classification, in fact, represents a rank and is commonly termed as **taxon** (pl.: taxa).

Explanation category Further denote Rank—Position in hierarch

Taxonomic category = taxon = Unit of classification = Part of taxonomic hierarchy

= Rank (position in hierarch)

of fact

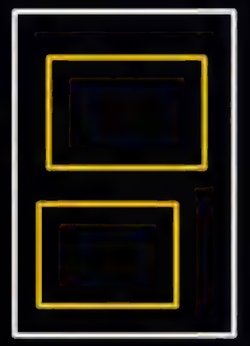
Taxonomic categories and hierarchy can be illustrated by an example. Insects represent a group of organisms sharing common features like three pairs of jointed legs. It means insects are recognisable concrete objects which can be classified, and thus were given a rank or category. Can you name other such groups of organisms? Remember, groups represent category. Category further denotes rank. Each rank or *taxon*, in fact, represents a unit of classification. These taxonomic groups/ categories are distinct biological entities and not merely morphological aggregates

obligate categories

- when we classify Any organism it Should be placed in some Categories

- These are minimum Seven categories organism should placed

→ These categories are part of all taxonomic Hierarchy



(Common characters ↑ Increase)

(No. of species ↓ Decrease)

- Kingdom – Keep
- phylum | Division (Plants) – Pot
- Class – Clean
- order – Super order → Order → Sub order
- Family – Family → Sub Family
- Genus – Get
- Species – Sick

– Sub category

Q Example of taxonomic category which can not be part of all Hierarchy

(a) Phylum (Division) (b) Family (c) Class (d) Subspecies

Q We can not classify organism without ____ category

(a) Superclass (b) Family (c) Subclass (d) Suborder

Taxonomical studies of all known organisms have led to the development of common categories such as kingdom, phylum or division (for plants), class, order, family, genus and species. All organisms, including those in the plant and animal kingdoms have species as the lowest category. Now the question you may ask is, how to place an

organism in various categories? The basic requirement is the knowledge of characters of an individual or group of organisms. This helps in identifying similarities and dissimilarities among the individuals of the same kind of organisms as well as of other kinds of organisms.

Species

-organism with Fundamental similarity | Species are Group of organism with Morphological similarity

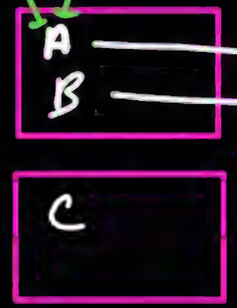
Ernst Mayer (Darwin of 20th Century) → Give definition of species → [Biological concept of species]

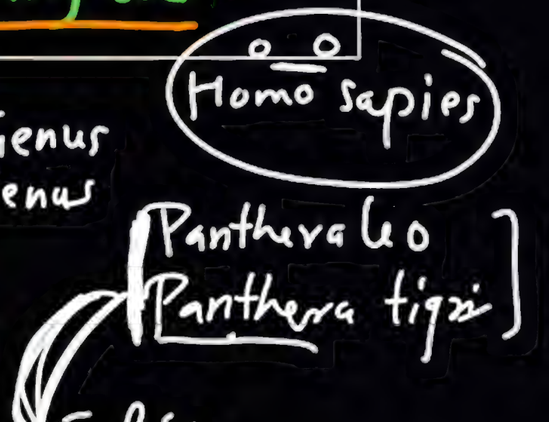
Species are Group of organism have Similarity Structure Which can interbreed and produce fertile Young one

→ Member of same species - Maximum Similarity

Q Maximum Similarity
(a) two organism of same species ✓
(b) two organism have same genus But different species
(c) two organism with Different Genus
(d) none

b > c
more similarity





Example of species

Genus Common

- Panthera tigris — tiger
- Panthera leo — Lion
- Panthera pardus → Leopard

Homo sapiens → Human

Musca domestica → Housefly

Mangifera indica — Mango

Triticum aestivum — Wheat

- Solanum melenogena – brinjal
- Solanum tuberosum – Potato
- Solanum nigrum – makoi

Common genus

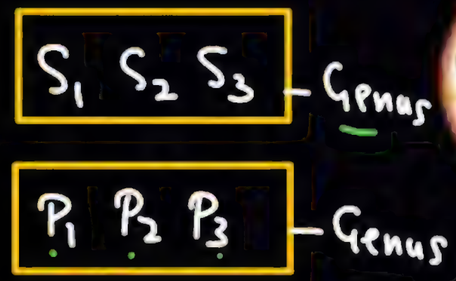
1.3.1 Species

genus ← species

Taxonomic studies consider a group of individual organisms with fundamental similarities as a **species**. One should be able to distinguish one species from the other closely related species based on the distinct morphological differences. Let us consider *Mangifera indica*, *Solanum tuberosum* (potato) and *Panthera leo* (lion). All the three names, *indica*, *tuberosum* and *leo*, represent the specific epithets, while the first words *Mangifera*, *Solanum* and *Panthera* are genera and represents another higher level of taxon or category. Each genus may have one or more than one specific epithets representing different organisms, but having morphological similarities. For example, *Panthera* has another specific epithet called *tigris* and *Solanum* includes species like *nigrum* and *melongena*. Human beings belong to the species *sapiens* which is grouped in the genus *Homo*. The scientific name thus, for human being, is written as *Homo sapiens*.

Genus

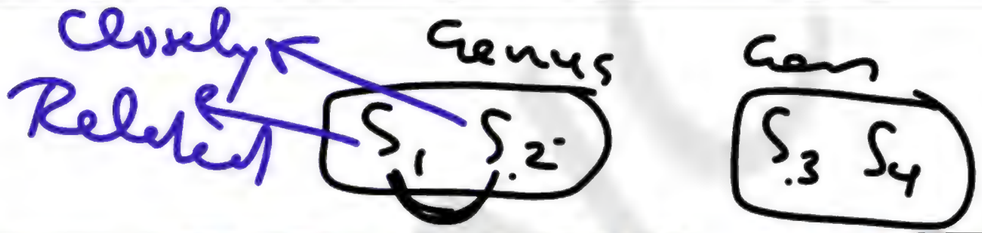
- Group of Related species
- Genus is higher category than species, less similarity ✓
- Two species Belong to same genus have more Similarity than two species of Different genus



- Panthera (genus) ⟶ tigris, leo, Pardus } more than one specific Epithet
- Homo (genus) → Sapiens (only one specific epithet)
- Felis (Cat genus)
- Canis (dog genus

S_1 & S_2 – Genus Same } more Similarity
S_1 & P_1 – Genus Different ← Compare to this

1.3.2 Genus



Genus comprises a group of related species which has more characters in common in comparison to species of other genera. We can say that genera are aggregates of closely related species. For example, potato and brinjal are two different species but both belong to the genus *Solanum*. Lion (*Panthera leo*), leopard (*P. pardus*) and tiger (*P. tigris*) with several common features, are all species of the genus *Panthera*. This genus differs from another genus *Felis* which includes cats.

Family

- Group of Related Genus
- In Animals → For Family - Suffix - idae
- In plants → For Family - Suffix use - aceae
⇒ In plants Family Classification done on the Basis of - Vegetative & Reproductive character

Species | Genus | Family

- Panthera tigris
- Panthera leo
- Panthera pardus

→ Panthera → Felidae

Felis (Cat) → Felidae

Mangifera indica → Mangifera → Anacardiaceae

Triticum Aestivum → Triticum → Poaceae

Musca domestica → Musca → Muscidae

Homo sapiens → Homo → Hominidae

Canis → Canidae (dog genus)

Solanum melanogena → Solanum → Solanaceae

Datura → Solanaceae

Suffix -idae

Suffix -aceae

Q More Similarity

(a) dog & Cat → Family ✗

(b) Datura & Solanum → Family same

(c) Felis & Panthera (Lion & tiger) → genus same

(Family same)

1.3.3 Family

The next category **Family**, has a group of related genera with still less number of similarities as compared to genus and species. Families are characterised on the basis of both vegetative and reproductive features of plant species. Among plants for example, three different genera *Solanum*, *Petunia* and *Datura* are placed in the family Solanaceae. Among animals for example, genus *Panthera*, comprising lion, tiger, leopard is put along with genus *Felis* (cats) in the family Felidae. Similarly, if you observe the features of a cat and a dog, you will find some similarities and some differences as well. They are separated into two different families – Felidae and Canidae, respectively.

Order

- Group of Related Family

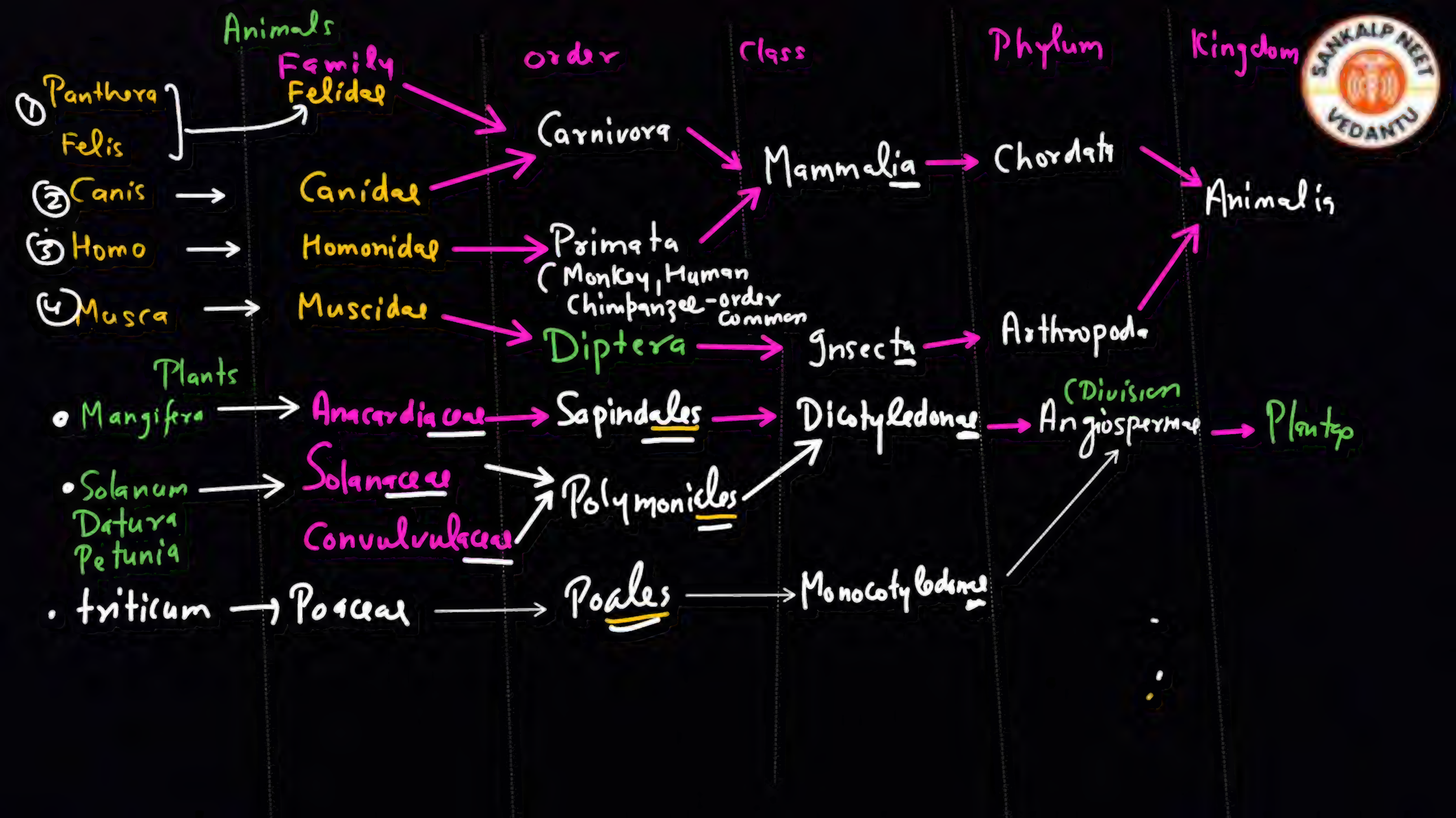
→ Species, Genus, Family → more characters common — (Type of character important)

→ order ⟶ Higher category ⟶ (Aggregation of Character)

↳ higher taxon

(Class, phylum)

Suffix – Plant – ales Animal – no Suffix


Animals
Family
Order
Class
Phylum
Kingdom
SANKALP NEET VEDANTU
① Panthera
Felis
Felidae
Carnivora
Mammalia
Chordata
Animalia
② Canis
Canidae
③ Homo
Homonidae
Primata
(Monkey, Human
Chimpanzee - order
common
④ Musca
Muscidae
Diptera
Insecta
Arthropoda
Plants
• Mangifera
Anacardiaceae
Sapindales
Dicotyledonae
(Division
Angiospermae
Plantae
• Solanum
Datura
Petunia
Solanaceae
Convulvulaceae
Polymonicles
• triticum
Poaceae
Poales
Monocotyledonae
∴

1.3.4 Order

You have seen earlier that categories like species, genus and families are based on a number of similar characters. Generally, order and other higher taxonomic categories are identified based on the aggregates of characters. Order being a higher category, is the assemblage of families which exhibit a few similar characters. The similar characters are less in number as compared to different genera included in a family. Plant families like Convolvulaceae, Solanaceae are included in the order Polymoniales mainly based on the floral characters. The animal order, Carnivora, includes families like Felidae and Canidae.

1.3.5 Class

This category includes related orders. For example, order Primata comprising monkey, gorilla and gibbon is placed in class Mammalia along with order Carnivora that includes animals like tiger, cat and dog. Class Mammalia has other orders also.

Chireptera – Bat

Class → Related order give class

Suffix for plants →
- ae – (Dicotyledonae)
- mycetes (Ascomycetes)
- Phyceae (Chlorophyceae) } Plant Kingdom
- opsida (Psilopsida – }

no Suffix For Animal

Phylum → Animals
Plants – Division

Kingdom

- Group of Phylum | Group of Division
- least common character

Kingdom
Phylum
Class

descending
Common Character Increase

Animals

Family → order → class → Phlum → Kingdom

Panthera →

Felis →

Canis →

Homo →

Musca →

Plants

Mangifera →

Solanum →

triticum →

1.3.6 Phylum

Classes comprising animals like fishes, amphibians, reptiles, birds along with mammals constitute the next higher category called Phylum. All these, based on the common features like presence of notochord and dorsal hollow neural system, are included in phylum Chordata. In case of plants, classes with a few similar characters are assigned to a higher category called Division.

cell theory

TABLE 1.1 Organisms with their Taxonomic Categories

Common Name	Biological Name	Genus	Family	Order	Class	Phylum/ Division
Man	*Homo sapiens*	*Homo*	Hominidae	Primata	Mammalia	Chordata
Housefly	*Musca domestica*	*Musca*	Muscidae	Diptera	Insecta	Arthropoda
Mango	*Mangifera indica*	*Mangifera*	Anacardiaceae	Sapindales	Dicotyledonae	Angiospermae
Wheat	*Triticum aestivum*	*Triticum*	Poaceae	Poales	Monocotyledonae	Angiospermae

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Morphology of Flowering plant

lecture - ०१

Botany

TARUN SIR

Topics

no. of Question – 4Q

1 Inflorescence →
2 Flower →
3 Fruit & Seed
4 Family →

→ 3Q or 4Q

Root]
Stem]
leaf]

Structure + ~~Modification~~ → 1Q

Part delete

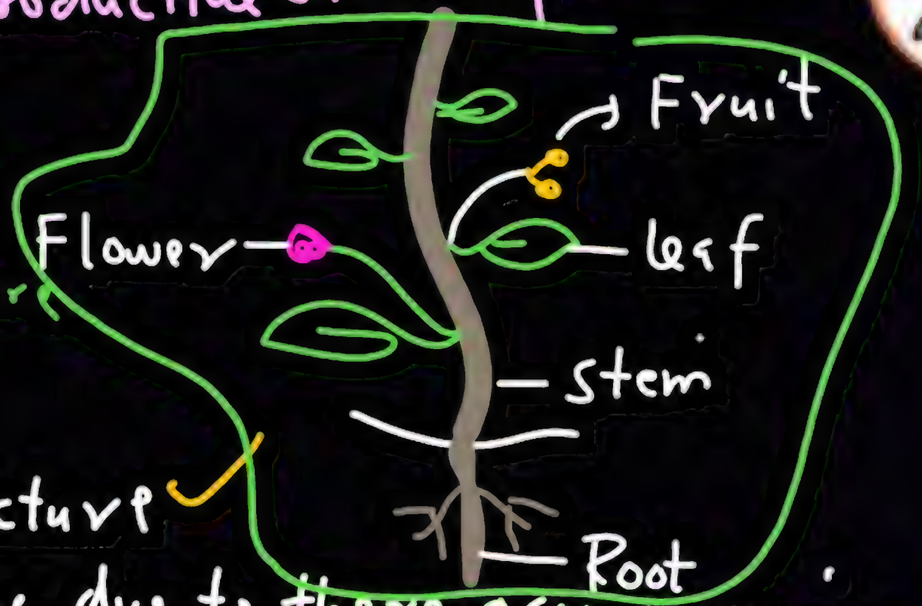
Morphology

→ It study of External structure
Both vegetative and Reproductive Structure

→ In Angiosperm, main stage is sporophyte

→ True Root, stem & leaf present – Vegetative Structure

→ Flower, Fruit & seed – Reproductive Structure



Both correct

Q S-I Angiosperm show Diversity in structure

S-II – Angiosperm Diversity in structure due to there occurence in wide habitat

The wide range in the structure of higher plants will never fail to fascinate us. Even though the angiosperms show such a large diversity in external structure or **morphology**, they are all characterised by presence of roots, stems, leaves, flowers and fruits.

Why we study Morphology — as a subject

1. For classification need to learn Standard terms (trimerous, tap Root) — For Classification
2. How Different part (stem, Root, leaf) Show change / Adaptation — For Classification
   - Ex- Cactus (opuntia) leaf modified into Spines
   - Use For Human Benefit (Many plant Source of Food ✓, Fibre ✓ Fodder ✓)

Why we study Morphology

In chapters 2 and 3 we talked about classification of plants based on morphological and other characteristics. For any successful attempt at classification and at understanding any higher plant (or for that matter any living organism) we need to know standard technical terms and standard definitions. We also need to know about the possible variations in different parts, found as adaptations of the plants to their environment, e.g., adaptions to various habitats, for protection, climbing storage, etc.

If you pull out any weed you will see that all of them have roots stems and leaves. They may be bearing flowers and fruits. The underground part of the flowering plant is the root system while the portion above the ground forms the shoot system (Figure 5.1).

Aerial Part

Underground part

Classification of Angiosperm plant structure

I Vegetative Part – Stem, Root and leaf

Reproductive Part – Flower, Seed, Fruit

II Aerial part (shoot system) – Stem, leaf, Flower & Fruit
(Above Ground)

Underground – Root & Root Branches
(Root System)

Important Examples

(Legumes Family)
Fabaceae → Gram, Arhar, moong, Sem, Bean, Soyabean, Groundnut
(Pea Family)
Sesbania, trifolium, Muliathi, Lupin, Sweet pea
indigofera, Sunhemp

Cruciferae
Brassicaceae → Mustard, Cabbage, Cauliflower, Radish
(Mustard Family)
turnip

Solanaceae – Potato, tomato, chilli, Brinjal, Makoi
Datura (Belladona), Ashwagandha, tobacco, Petunia

Dicot

Liliaceae → Lily, Onion (Allium cepa), Aloe, Asparagus
monocot
Colchicum, tulip, Gloriosa

SANKALP NEET VEDANTU

IV Malvaceae → Cotton, Lady Finger (Okra), China rose] Dicot

V Poaceae (Graminae) → Wheat, Rice, Oat (Avena sativa), Bamboo, Sugarcan, Maize, Grass] Monocot
(Wheat Family)
(Grass Family)

VI Asteraceae → Sunflower, Marigold] Dicot
(Sun flower)
(Compositaeae)

Q Sunflower, Mustard, Chilli, Lily, Lupine, Aloe
Maize, Rice, Gram, Bean

Dicot – 6
Monocot – 4

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Q Few Ex- Are Given (FEAG)

Potato (S), Pea (F), Petunia (S), Aloe (L), Lily (L), Datura (S), Muliathi (F), tobacco (S), Mustard (B), Raddish (B)

How many are in

(a) Brassicaceae – 2 — 3
(b) Fabaceae – 2 — 4
(c) Solanaceae – 4 — 3
(d) Liliaceae – 2 — 3

Q FEAG → Moong (F), turnip (B), indigofera (F), Sunhemp (F), tobacco (S), Makoi (S), Onion (L), chilli (S), Aloe (L), colchicum (L), Groundnut (F), Cauliflower (B), Mustard (B)

① Racemose inflorescence present in

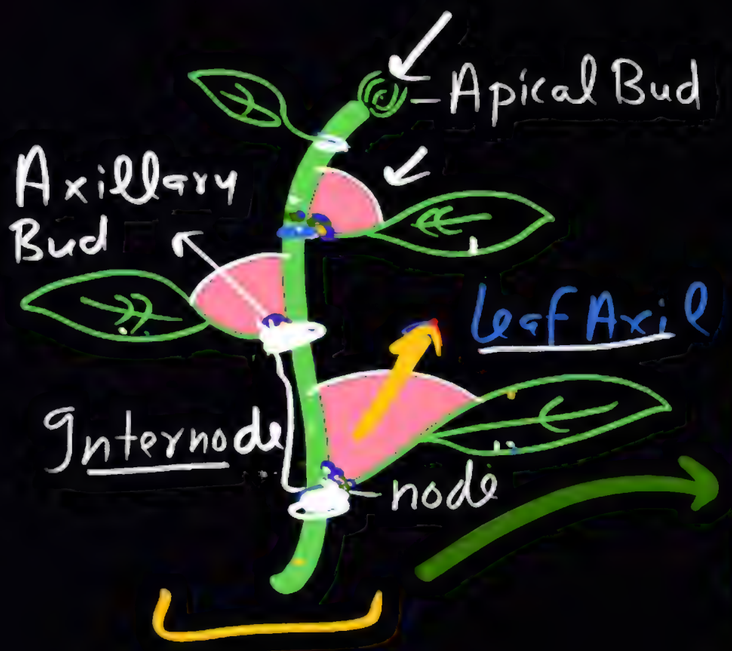
(a) Brinjal → Solanaceae
(b) ~~Pea~~ — Fabaceae
(c) Aloe → Liliaceae
(d) tomato → Solanaceae

Brassicaceae, Fabaceae → Racemose

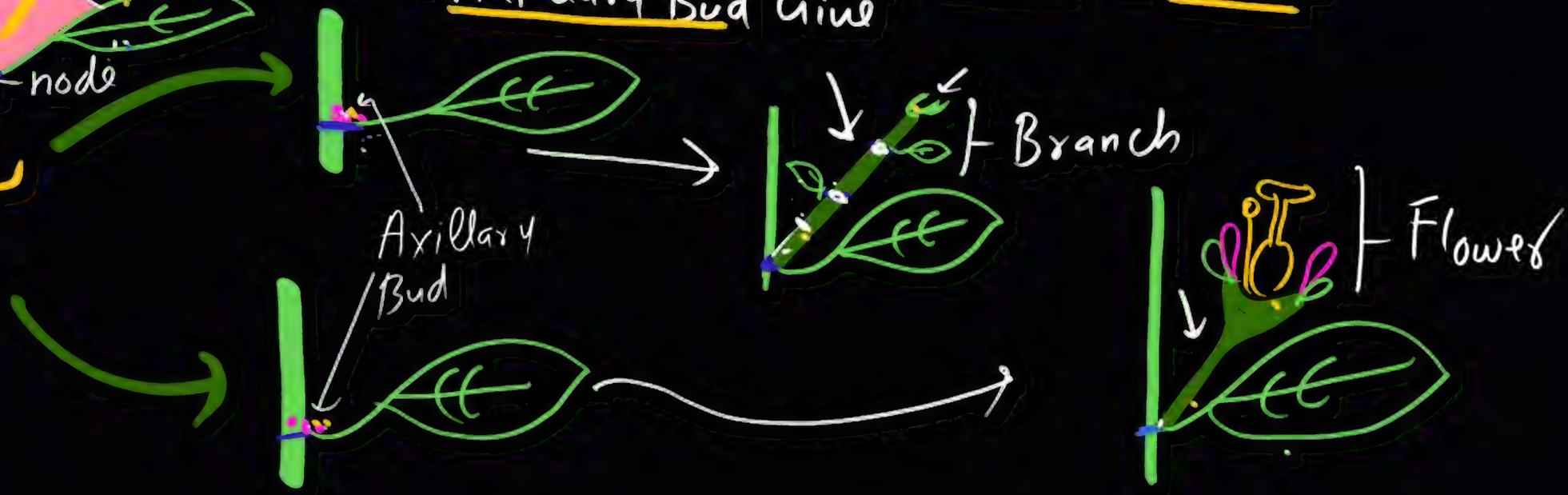
Solanaceae, Liliaceae → Cymose

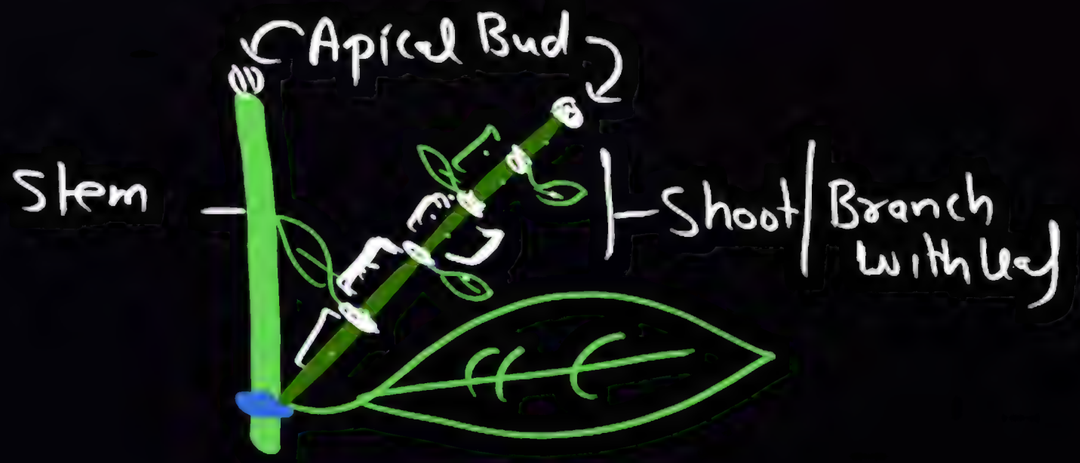
Infloresense

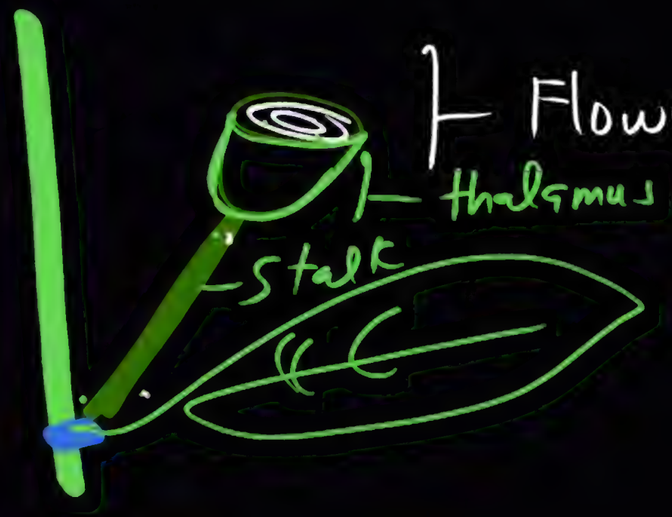
→ What is Flower, How it develop



- Apical Bud - present at tip of Branch or Stem
- Leaf present on node
→ Area B/w leaf & Stem → Leaf Axil
→ Bud develop on leaf Axil → Axillary Bud
→ Axillary Bud Give → Branch or Flower







Flower - condensed Shoot, internode get condensed and nodes come together & Form Receptacle / thalamus

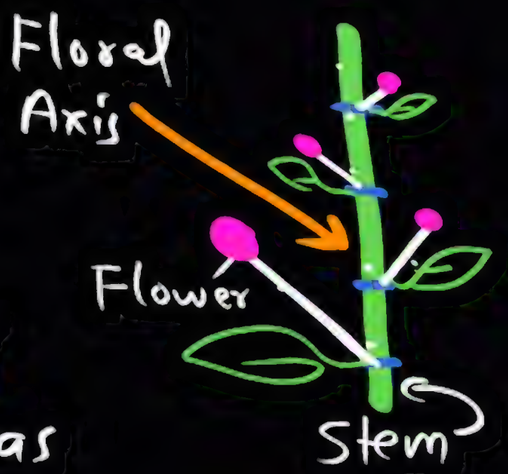
what is **Floral Axis**

—Branch or stem on which Flower develop

Inflorescence- Arrangement of Flower on Floral Axis is known as Inflorescence

Type of inflorescence

(a) Racemose ✓
(b) Cymose ✓
(c) Solitary ✓



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Racemose

- Floral Axis - indefinite Growth and Flower develop By Axillary Bud
- old Flower - close to Base Young Flower at top

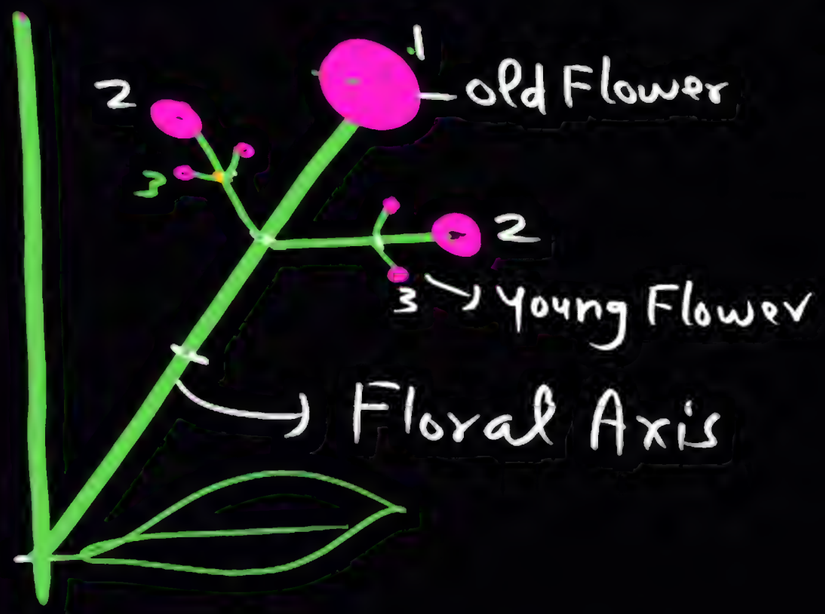
Flower develop in Acropetal Arrangement

Example → Brassicaceae
→ Fabaceae
→ Asteraceae ✓
→ Poaceae ✓

Q Racemose inflorescence
(a) Solanum
(b) Lily
(c) Chilli
(d) Maize

Cymose → Floral Axis – definite Growth, terminate into Flower

Old Flower at top
Young Flower at Base
) – Basipetal Arrangement



Ex – Solanaceae
– Liliaceae
– Malvaceae

Q Racemose inflorescent Absent in
(a) Mustard (b) tomato (c) Sunflower (d) Bean
Br Sol Ast Fa

Q Floral Axis indefinite Growth
S L
(a) Petunia (b) onion
(c) Sunhemp (d) Chilly
F S

DOPA - 01

Q1 S-I - Flower is condensed shoot
S-II - Branch develop From Axillary Bud

Q2 S-I stem & shoot is same
S-II leaf Axil present on stem not Branch

Q3 S-I Flower is modified shoot
S-II Floral Axis can be main stem not Branch

Q4 S-I Racemose inflorescence have indefinite Growth
S-II Cymose have definite Growth

Q5 - S-I Mustard have Racemose inflorescence
S-II Maize have Cymose inflorescence

Q6 Few Ex- Solanum, petunia, Sunflower, Pea, Bean
How many Racemes
(a) two (b) three (c) Four (d) Five

Q7 Cymose inflorescence present in
(a) Marigold (b) Aloe (c) Muliathi (d) Cabbage

Q8 Racemose inflorescence present in
(a) Mustard (b) Pea (c) turnip (d) all

Q9 Acropetal Arrangement present in inflorescence of
(a) Maize (b) Potato (c) Chilli (d) onion

Q10 Basipetal Arrangement present in
(a) Gloriosa (b) tobacco (c) Asparagus (d) all

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SANKALP NEET VEDANTU

Morphology of Flowering plant

lecture - 02

Botany

TARUN SIR

Topics

no. of Question – 4Q

1. Inflorescence →
2. Flower →
3. Fruit & Seed
4. Family →

→ 3Q or 4Q

Root]
Stem]
leaf]

Structure + Modification → 1Q

Part delete

cell theory

Important Examples

(Legumes Family)
Fabaceae → Gram, Arhar, moong, Sem, Bean, Soyabean, Groundnut
(Pea Family)
Sesbania, trifolium, Muliathi, Lupin, Sweet pea
indigofera, Sunhemp

Dicot

(Cruciferae)
Brassicaceae → Mustard, Cabbage, Cauliflower, Radish
(Mustard Family)
turnip

Solanaceae – Potato, tomato, chilli, Brinjal, Makoi
Datura (Belladona), Ashwagandha, tobacco, Petunia

Liliaceae → Lily, Onion (Allium cepa), Aloe, Asparagus
monocot
Colchicum, tulip, Gloriosa

IV Malvaceae → Cotton, Lady Finger (Okra), China rose] Dicot

V Poaceae (Graminae) → Wheat, Rice, Oat (Avena sativa), Bamboo, Sugarcan, Maize, Grass] Monocot
(Wheat Family)
(Grass Family)

VI Asteraceae → Sunflower, Marigold] Dicot
(Sun flower)
(Compositaeae)

Q Sunflower, Mustard, Chilli, lily, Lupine, Aloe
D D D M D M
Maize, Rice, Gram, Bean
M M
Dicot – 6
Monocot – 4

DOPA - 01

Q1 S-I - Flower is condensed shoot ✓
S-II - Branch develop From Axillary Bud ✓] Both wrong

Q2 S-I stem & shoot is same X (→ Stem + Leaf)
S-II leaf Axil present on stem not Branch X] Both wrong

Q3 S-I Flower is modified shoot ✓
S-II Floral Axis can be main stem not Branch X] only a correct

Q4 S-I Racemose inflorescence have indefinite Growth ✓
S-II Cymose have definite Growth ✓ Floral ✓] Both

Q5 - S-I Mustard have Racemose inflorescence ✓
S-II Maize have Cymose inflorescence X (↳ Poaceae)] only I

C C R R R

Q6 Few Ex- Solanum, petunia, Sunflower, Pea, Bean
How many Racemes
(a) two (b) three (c) Four (d) Five

Racemose →
- Brassicaceae
- Fabaceae
- Poaceae
- Asteraceae

Cymose ✓
- Solanaceae
- Liliaceae
- Malvaceae

Q7 Cymose inflorescence present in
(a) Marigold (b) Aloe (c) Muliathi (d) Cabbage

Q8 Racemose inflorescence present in
(a) Mustard (b) Pea (c) turnip (d) all

Q9 Acropetal Arrangement present in inflorescence
(a) Maize (b) Potato (c) Chilli (d) onion

Q10 Basipetal Arrangement present in
(a) Gloriosa (b) tobacco (c) Asparagus (d) all

Flower

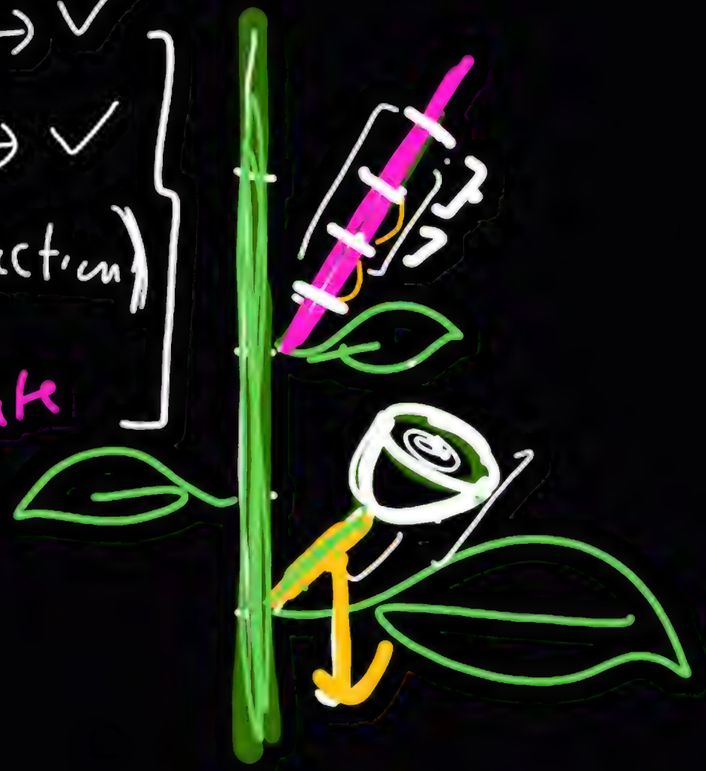
What is Flower

→ modified shoot → ✓

→ Reproductive unit → ✓

(Role in Sexual Reproduction)

Flower develop – internode not Elongate all nodes come at one point



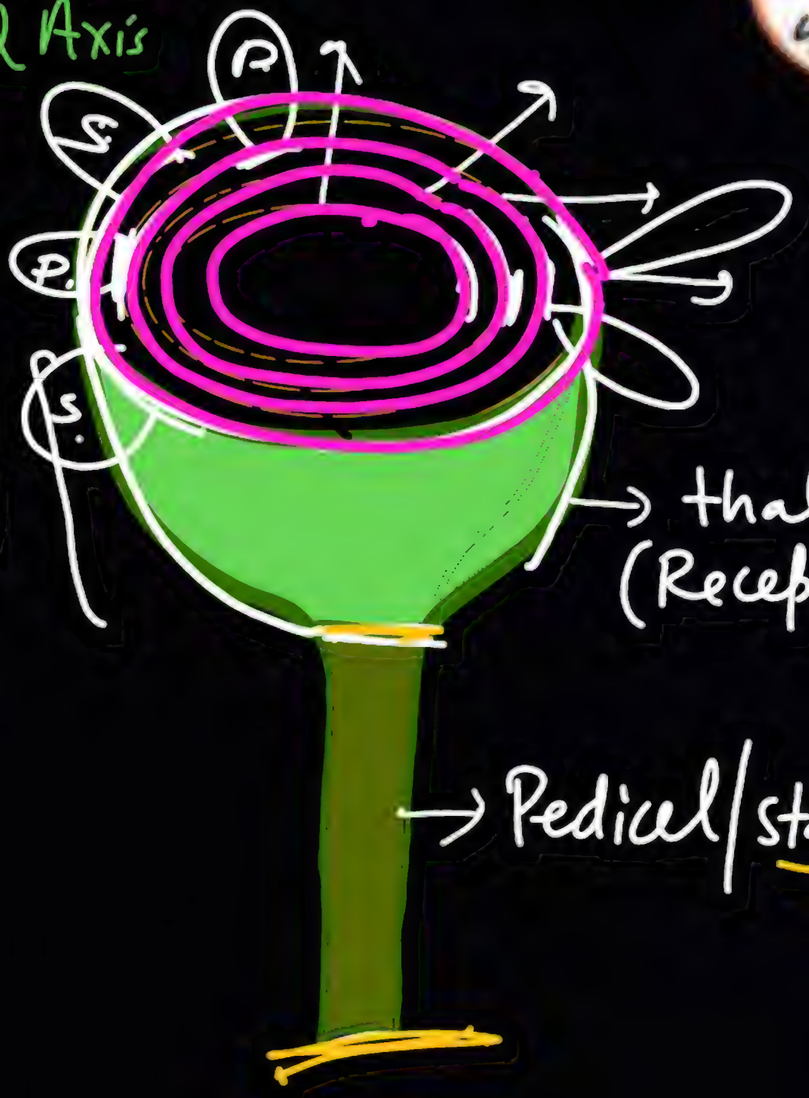
structure of Flower

(a) Pedicel – stalk which attach Flower on Floral Axis

(b) thalamus → Broad structure Present at tip/Apex of Pedicle

(c) Whorl
↳ on thalamus, Floral Appendage (organ like sepal, petal) develop in whorl (circle)

Four type of whorl →



Type of whorl

(a) Calyx – Whorl of sepal

(b) Corolla – Whorl of petal

] Accessory whorl (no Direct Role in Sexual Reproduction)

(c) Androceium – Anther, Filament] Stamen → Whorl of stamen

(d) Gynoceium → Pistil → Whorl is Gynoceium

note – Androceium & Gynoceium – Essential Whorl

Perianth → In monocot, sepal & petal not distinct
Whorl of tepal – perianth

Q Perianth present in

(a) Mustard (b) Sunflower (c) Pea (d) Wheat

(Liliaceae, Poaceae)

Q Flower is Bisexual, But three whorl (Different type)

(a) Pea (b) Lily (c) Mustard (d) China rose

$C_a\ C_o$ $\bar{A}$ $\bar{G}$ X $\quad \bar{G}\ C_o\ A$

$P^2\ \bar{A}^3\ \bar{G}^1$ — Monocot Flower

1 2 3

Type of Flower

(a) Unisexual or Bisexual Flower]

(b) Symmetery in Flower]

(c) Isomery in Flower]

(d) Position of ovary in Flower]

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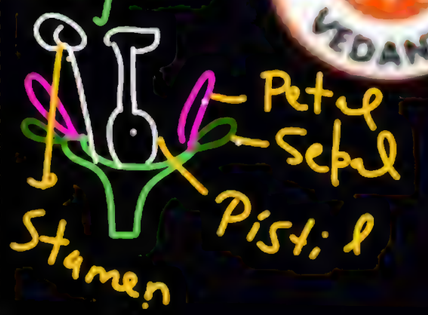
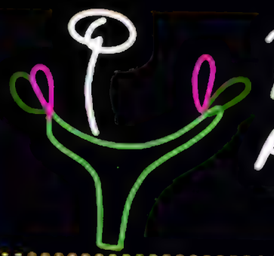
Unisexual or Bisexual Flower

	no. of whorl	Whorl Absent	Symbol	Diagram
Bisexual Flower Mustard, pea, Lily, Wheat, China rose (most Families)	all Four Whorl Present	Zero	♂ ♀	
Male Flower (Staminate)	3 Gynoceium Absent, Stamen Present ←	1	♂	 Pistil Absent
Female Flower (Pistillate)	3 Stamen Absent, Pistil Present	1	♀	

Q Pistillate Flower – true

(a) All Four whorl present

(b) Member of Acessory whorl Absent

(c) Both Essential whorl Absent

~~(d)~~ One Essential Whorl Absent

Unisexual Flower

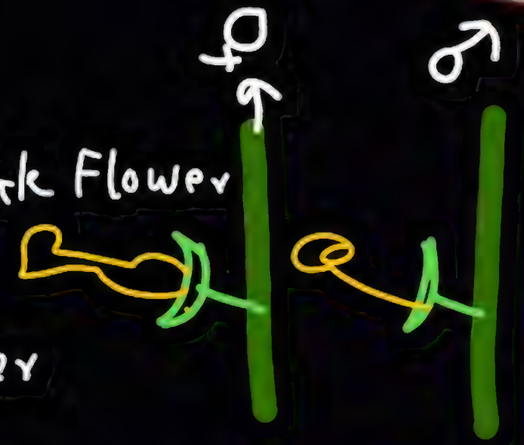
Plant Bisexual (Monoecious)

- Pistillate & Staminate Flower on same plant

Ex → Cucumber, Maize
→ Castor, Coconut

Plant unisexual

- One plant have pistillate Flower
Another have Staminate Flower



Ex- Date palm, Papaya
- Vallisneria, Mulberry

Q Staminate Flower present in
(a) Maize (b) Papaya (c) Mulberry ~~(d) all~~

Q Both staminate & pistillate Flower on same plant
(a) Date palm (b) Castor (c) Papaya ~~(d) all~~

Asymmetric

Canna

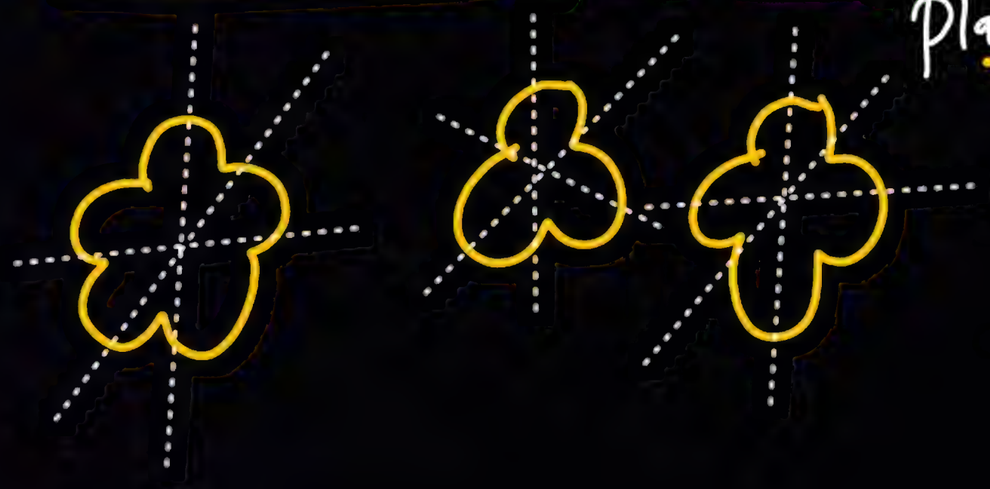
Symmetry in Flower

meaning - When Any Flower, cut by Any Plane, two Equal half From

Type of Flower
- Asymmetric → no Symmetery present, not able to cut into two equal half By Any Plane
  Ex - Canna
- Have Symmetery → (a) Radial
  (b) Bilateral

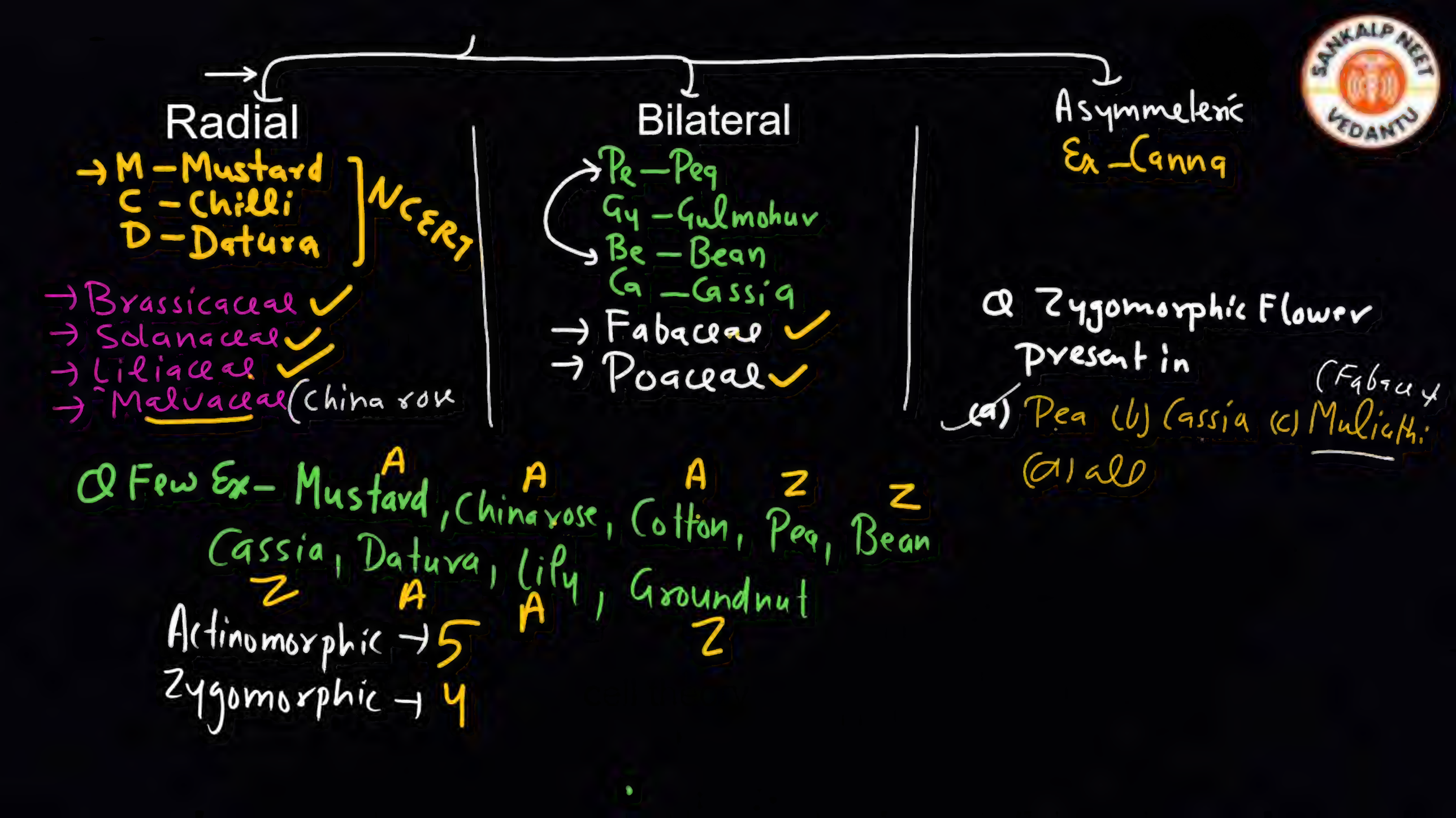
Radial | Actino morphic →

- Flower can be cut into two Equal half By Many Radial Plane



Bilateral | Zygomorphic →

Flower Divide into two Equal half By only one vertical plane


Radial
M – Mustard
C – Chilli
D – Datura
NCERT
Brassicaceae
Solanaceae
Liliaceae
Malvaceae (China rose
Bilateral
Pe – Pea
Gu – Gulmohur
Be – Bean
Ca – Cassia
Fabaceae
Poaceae
Asymmetric
Ex – Canna
Q Few Ex – Mustard, China rose, Cotton, Pea, Bean
Cassia, Datura, Lily, Groundnut
Actinomorphic → 5
Zygomorphic → 4
Q Zygomorphic Flower present in
(a) Pea (b) Cassia (c) Mulethi (Fabaceae)
(a) all

Q Few Ex- Pea (F), Maize (Po), Bean (F), Cotton (M), tobacco (S), Onion (L), Cabbage (Br), turnip (Br), tulip (Li)

(a) Zygomorphic → F, Po → 2 + 1 = 3

(b) Actinomorphic → M + S + B + L = 6

(c) Racemose → B + F + P = 2 + 2 + 1 = 5

(d) Cymose → S + L + M → 1 + 2 + 1 = 4

3654

Q Few Ex- Groundnut (F), Mustard (B), Cotton (M), lady Finger (M), Bean (F), China rose (M), Onion (L), Ashwagandha (S), chilli (S), Aloe (L), turnip (B)

(a) Zygo → 2(F)

(b) Actino → 9 (B-2 + M=3 + S=2 + L=2 = 9

(c) Racemose → B + F + → 4

(d) Cymose → 3 + 2 + 2 = 7

2947

Inflorescence
- Racemose → Brassicaceae, Fabaceae, Asteraceae, Poaceae
- Cymose → Solanaceae, Liliaceae, Malvaceae

Symmetry
- Actinomorphic: Brassicaceae, Solanaceae, Liliaceae, Malvaceae
- Zygomorphic: Fabaceae, Poaceae
- Asymmetric – Canna

Isomery
- tetra – Brassicaceae
- trimerous → Poaceae, Liliaceae
- Penta → Fabaceae, Solanaceae, Asteraceae, Malvaceae

Isomery – Appendage | Floral organ are in Multiple of 3, 4, 5

(Sepal, Petal, Stal)

Type of Isomery	Example
(a) tetramerous	Multiple of 4 → Ex- Brassicaceae (Mustard)
(b) Pentamerous	Multiple of 5 → • Solanaceae • Fabaceae • Malvaceae, Asteraceae
(c) Trimerous (Monocot)	Multiple of 3 → Liliaceae, Poaceae

Dicot

Monocot

Q Tetramerous Flower

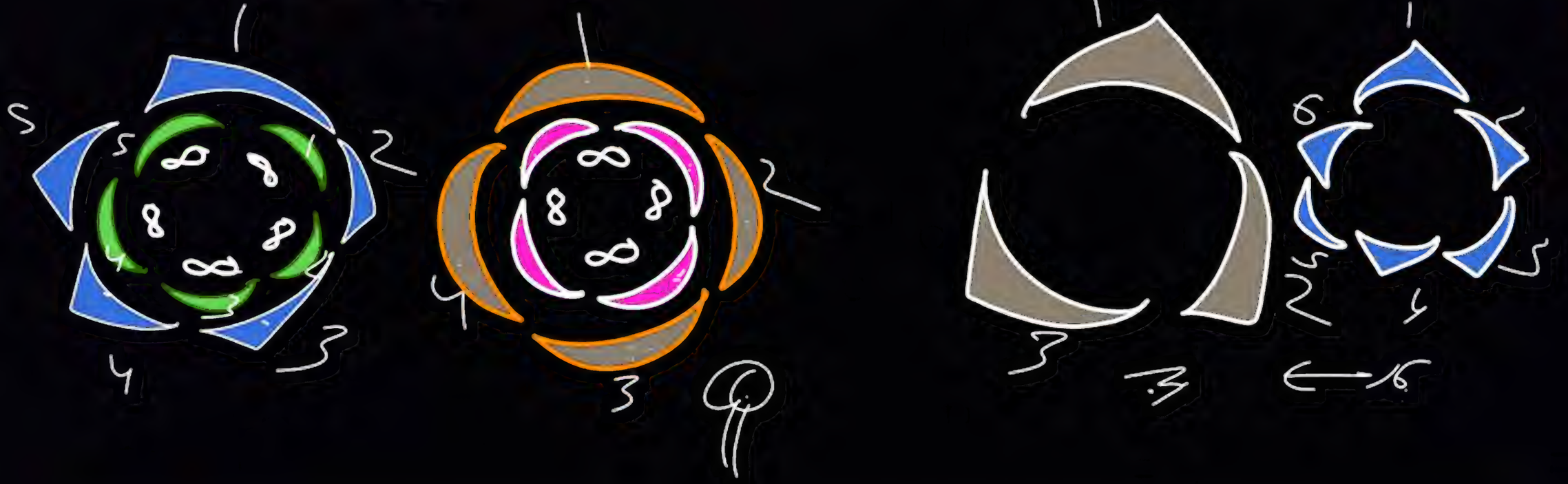
(a) Pea – 5

(b) Cabbage (Cliching ~~ruk~~) – 5

(a) Wheat – 3

note – Floral whorl generally not show Isumery = Gynoecium

Isomery



A flower may be **trimerous, tetramerous** or **pentamerous** when the floral appendages are in multiple of 3, 4 or 5, respectively. Flowers

Q Which is Feature of monocot

(a) three sepal ✗ (b) three stamen ✓ (c) three petal ✗ (d) Five petal ✗

Q Which is not Dicot Feature

(a) ⊕ (b) ⚥ (c) P_3 (d) K_5

⊕ ⚥ P_3 ⊥ Mon K_5 5 sepal

Bract

- At Base of Flower - Reduced/small leaf like structure
  Bract present - Bracteate → Br (Symbol)
  Bract Absent - Ebracteate - EBr (Symbol)

the floral appendages are in multiple of 3, 4 or 5, respectively. Flowers with bracts-reduced leaf found at the base of the pedicel-are called **bracteate** and those without bracts, **ebracteate.**

⊕ ♂ Br

DOPA-02

Q1 Racemose inflorescence
(a) Solanum (b) Lily (c) Cabbage (d) Cotton

Q2 Not true About china rose
(a) Racemose (b) Cymose (c) Malvaceae (d) Actinomorphic

Q3 Pea, Bean, Datura, Mustard, tobacco, Groundnut
How many Zygomorphic
(a) two (b) three (c) Four (d) Five

Q4 Pentamerous, Zygomorphic
(a) Wheat (b) Maize (c) Sweet pea (d) all

Q5 trimerous Flower
(a) Rice (b) Lily (c) Onion (d) all

Q6 Sunflower & Wheat have similarity

(a) Racemose (b) Symmetery (c) Trimerous (d) tetramerous

Q7 Perianth present in

(a) Mustard (b) Gloriosa (c) China rose (d) Chilli

Q8 Chilli & China rose have Similarity

(a) Racemose (b) Cymose (c) Monocot (d) Zygomorphic

Q9 Zygomorphic & Racemose

(a) Moong (b) Arhar (c) indigofera (d) all

Q10 tetramerous Flower →(a) Solanaceae (b) Fabaceae (c) Brassicaceae (d) Poaceae

Q11 Few Ex-

Sesbania cotton Chinarose Makoi Muliathi Groundnut

Lupin Lady Finger Wheat Maize lily tulip Cabbage

Cauliflower Sunhemp

(a) Trimerous (d) Actino (g) Pentamerous

(b) tetramerous (e) Zygo

(c) Racemose (f) Cymose

MANTHAN NEET 2025 - 1.0 & 2.0

SANKALP NEET VEDANTU

Morphology of Flowering plant

lecture - 03

Botany

TARUN SIR

Topics

no. of Question – 4Q

1. Inflorescence →
2. Flower →
3. Fruit & Seed
4. Family →

→ 3Q or 4Q

Root]
Stem]
leaf]

Structure + Modification → 1Q

Part delete

Important Examples

(Legumes Family)
Fabaceae → Gram, Arhar, moong, Sem, Bean, Soyabean, Groundnut
(Pea Family)
Sesbania, trifolium, Muliathi, Lupin, Sweet pea
indigofera, Sunhemp

Cruciferae
Brassicaceae → Mustard, Cabbage, Cauliflower, Radish
(Mustard Family)
turnip

Solanaceae – Potato, tomato, chilli, Brinjal, Makoi
Datura (Belladona), Ashwagandha, tobacco, Petunia

Dicot

Liliaceae → Lily, Onion (Allium cepa), Aloe, Asparagus
Colchicum, tulip, Gloriosa

monocot

SANKALP NEET VEDANTU

IV Malvaceae → Cotton, Lady Finger (Okra), China rose] Dicot

V Poaceae (Graminae) → Wheat, Rice, Oat (Avena sativa), Bamboo, Sugarcan, Maize, Grass] Monocot
(Wheat Family)
(Grass Family)

VI Asteraceae → Sunflower, Marigold] Dicot
(Sun flower)
(Compositaeae)

Q Sunflower, Mustard, Chilli, lily, Lupine, Aloe
Maize, Rice, Gram, Bean
Dicot – 6
Monocot – 4

SANKALP NEET VEDANTU

Inflorescence
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DOPA-02

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S L B M

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Q3 Pea, Bean, Datura, Mustard, tobacco, Groundnut

How many Zygomorphic

(a) two (b) three (c) Four (d) Five — b

Q4 Pentamerous, Zygomorphic — Pe Gu Be C

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Fi Z

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Ri Li

(Aster.) (P

Q6 Sunflower & Wheat have similarity

(a) Racemose (b) Symmetery (c) Trimerous (d) tetramerous

Q7 Perianth present in 7 – b

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S. M.

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X X (X

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(a) Moong (b) Arhar (c) indigofera (d) all

Q10 tetramerous Flower → (a) Solanaceae (b) Fabaceae (c) Brassicaceae (d) Poaceae

Q11 Few Ex-

F Sesbania, M cotton, M Chinarose, S Makoi, F Muliathi, F Groundnut

F Lupin, M Lady Finger, P Wheat, P Maize, L lily, L tulip, Br Cabbage

Br Cauliflower, F Sunhemp

L+P 2 2

(a) ~~Trimerous~~ - 4

Br (b) tetramerous = 2

(c) Racemose = 9

Br + F + P
2 5 2

(d) Actino - 8

(e) Zygo → 7 (F + P)
5 2

(f) Cymose → M + S + L = 6
3 1 2

5 1 3

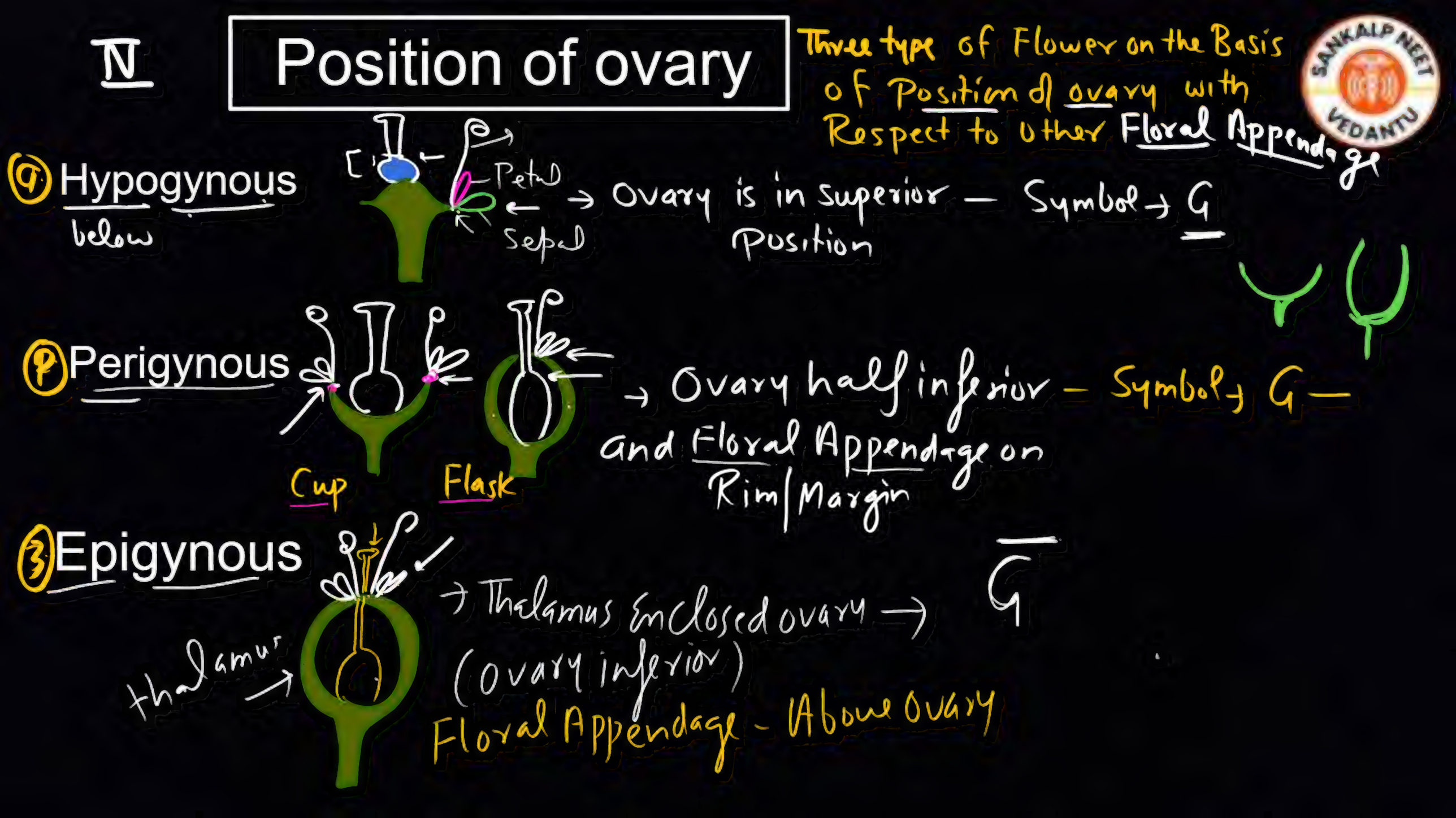
(g) Pentamerous - F + S + M = 9

Y29876

N

Position of ovary

Three type of Flower on the Basis of Position of ovary with Respect to other Floral Appendage



① Hypogynous
below

→ Ovary is in superior Position — Symbol → G

② Perigynous

→ Ovary half inferior — Symbol → G
and Floral Appendage on Rim/Margin

③ Epigynous

→ Thalamus enclosed ovary → $\overline{G}$
(ovary inferior)
Floral Appendage - Above Ovary

Hypogynous

H – M – Mustard
C – China rose
B – Brinjal

Brassicaceae, Fabaceae, Solanaceae, Liliaceae
Poaceae, Malvaceae

→ Mango, Coconut ⟶

Perigynous

P
R – Rose
P – Plum
P – Peach

→ Rosaceae → other member – Lotus

Epigynous

Ɛ
Cu – Cucumber ⟶ other Ex – Watermelon, pumpkin, Bitter gourd, Bottle gourd
Gu – Guava
Su – Sunflower (Ray Floret of Sunflower)
(Marigold)

H → M C B
P – R, P, P
Ɛ → Cu Gu Su

Sunflower → Asteraceae – It is not a Single Flower, Group of Flower (two type of Flower)

(a)
Ray Floret
(Flower)
% – Zygomorphic ✓
– Epigynous
– Female Flower

Racemose Head / Capitulum – named inflorescence

Q Inferior ovary present in

(a) Plum (b) Cucumber (c) China rose (d) Mustard
Epi Hy Hy

Q Half inferior ovary (R, P, P)

(a) Rose (b) Sunflower (c) Guava (d) Peg ←
Epi Epi Hyp

Q Few Ex- Rose, Cucumber, watermelon, mango, coconut
P E E H H

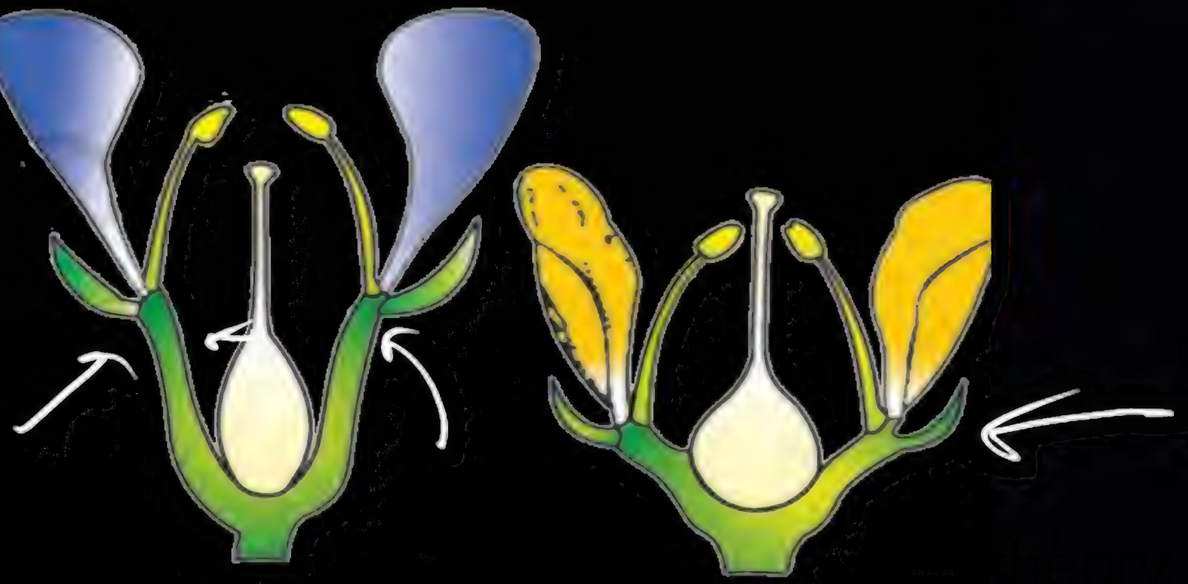
Pea, Bean, China rose, Plum, Peach, Sunflower, Guava
H H H P P E E

Q H → 5
P → 3
E → 4

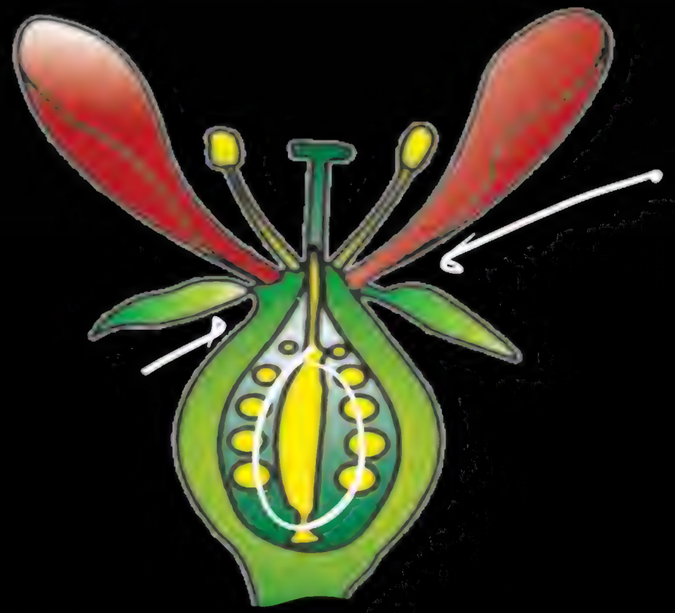
5, 3, 4

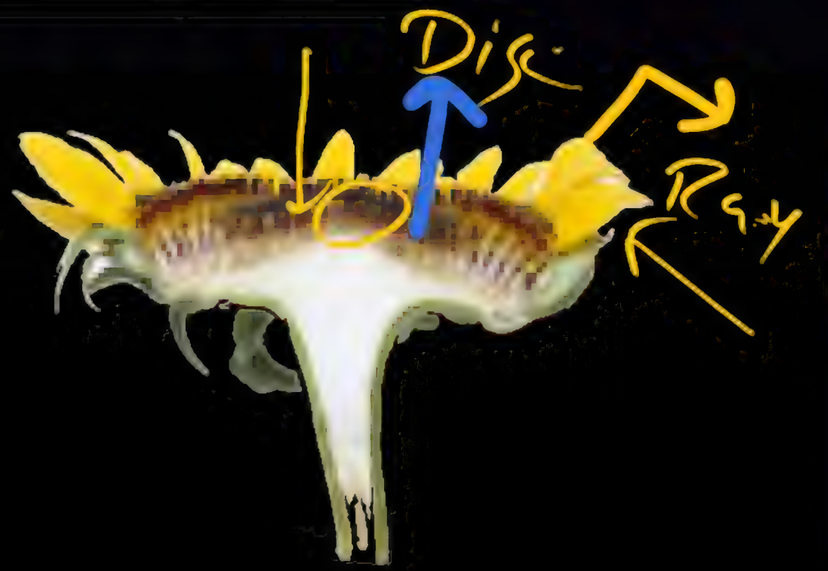
In the **hypogynous** flower the gynoecium occupies the highest position while the other parts are situated below it. The ovary in such flowers is said to be **superior,** e.g., mustard, china rose and brinjal.

!. If gynoecium is situated in the centre and other parts of the flower are located on the rim of the thalamus almost at the same level, it is called **perigynous.** The ovary here is said to be **half inferior,** e.g., plum, rose, peach.



. In **epigynous flowers,** the margin of thalamus grows upward enclosing the ovary completely and getting fused with it, the other parts of flower arise above the ovary. Hence, the ovary is said to be **inferior** as in flowers of guava and cucumber, and the ray florets of sunflower.





→ Sunflower – Epi

1. Ray florets have: (2020)

a. Superior ovary ✗

b. Hypogynous ovary ✗

c. Half inferior ovary

d. Inferior ovary

28. Perigynous flowers are found in: (2015)

a. China rose

b. Rose

c. Guava

d. Cucumber

29. Ovary is inferior in: (2015)

a. Guava b. Rose c. China rose d. Peach

3. The ovary is half inferior in: (2020)

a. Mustard

b. Sunflower

c. Plum

d. Brinjal

50. Flowers are zygomorphic in: (2011 Pre)

a. *Datura* — S

b. Mustard — B

c. Gulmohur

d. Tomato — S

39. Among bitter gourd, mustard, brinjal, pumpkin, china rose, *Lupin*, cucumber, sun hemp, gram, guava, bean, chili, plum, *Petunia*, tomato, rose, *Withania somnifera*, potato, onion, Aloe and tulip how many plants have hypogynous flower? (2013)

a. Eighteen

b. Six

c. Ten

d. Fifteen

27. Keel is the characteristic feature of flower of: (2015)

a. Aloe — Vexillary

b. Tomato

c. Tulip

d. *Indigofera*

Q Few Ex— Pea (F), Groundnut (F), cotton (M), okra (M), Cassia, gulmohur

Vexillary — 2
twisted — 2
Imbricate — 2

Zygomorphic = 4
Actinomorphic = 2

Parts of a Flower

Each flower normally has four floral whorls, viz., calyx, corolla, androecium and gynoecium (Figure 5.10).

Flower have → Four type of whorl
(a) Calyx (b) Corolla (c) Androceium (d) Gynoceium

Calyx – Role of Calyx – Protection

– Whorl of Sepal – Calyx → Symbol → K

– Sepals can be Free → Polysepalous → K_5

Sepals can be Fuse – Gamosepalous → $K_{(5)}$

5 sepals

K_5 = Symbol

Diagramme

K_5 – 5 sepals, Free-Polysepalous

$K_{(5)}$ → 5 sepals, Gamosepalous

$K_{\overset{\text{outer}}{2}+2}$ → Inner

(Sepal is Four two whorl)

K_{3+2}

$K_{(3)+(2)}$

$K_{(3+2)}$

Parts of a Flower

5.5.1.1 Calyx

The calyx is the outermost whorl of the flower and the members are called sepals. Generally, sepals are green, leaf like and protect the flower in the bud stage. The calyx may be **gamosepalous** (sepals united) or **polysepalous** (sepals free).

corolla →

→ Inner to calyx, another whorl → Corolla

→ Whorl of petals = Corolla –

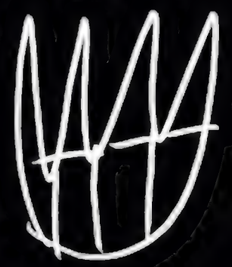
→ Corolla – coloured – Attract insect – For pollination

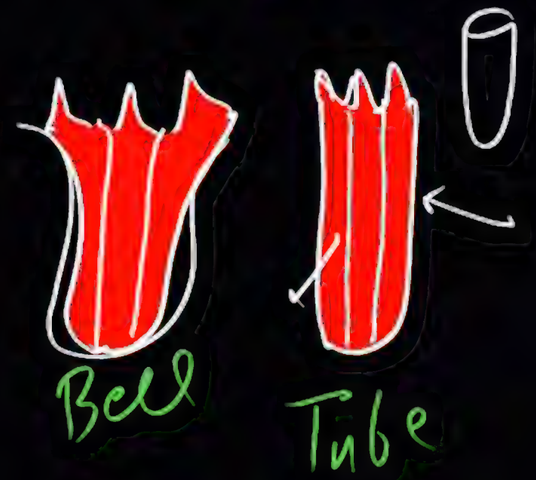
→ Petals Free → Polypetalous → C_S

→ Petals Fuse – Gamopetalous → $C_{(S)}$

(When petals Fuse – Different shape From)

tube, bell, wheel)





$C_5 \rightarrow$ Polypetalous

$C_{(5)}$ Gamopetalous

Fabaceae → $C_{1+2+(2)}$ (5 petals three whorl

note - Solanaceae gamosepalous & gamopetalous present ✱ - $K_{(5)} C_{(5)}$

- Liliaceae & Poaceae - tepals present → And whorl is perianth

$P_{(3+3)}$ - liliaceae

Parts of a Flower

5.5.1.2 Corolla

Corolla is composed of petals. Petals are usually brightly coloured to attract insects for pollination. Like calyx, corolla may also be **gamopetalous** (petals united) or **polypetalous** (petals free). The shape and colour of corolla vary greatly in plants. Corolla may be tubular, bell-shaped, funnel-shaped or wheel-shaped.

Aestivation

- It is Arragment of sepals with Respect to other sepal
  Petal with Respect to other petal (within whorl - ∪, B|w whorl → X)
- Observe in Bud stage (Aestivation)

Type of Aestivation

1. Valvate - most common - Ex - Calotropis
2. twisted → Cotton, China rose, lady Finger - Co, Chin, La (Malvaceae)
3. Imbricate - Cassia, Gulmohur
4. Vexillary → Pea, Bean (Fabaceae)

① Valvate

Margin

- Margins not Overlaps

Ex- Calotropis

Twisted

- Margins of sepal or petal overlap So on (Regular Pattern)

Ex- Co, Chin, Ia. (Malvaceae)

Imbricate

Margin overlap But not in Regular pattern

Ex- Cassia Gulmohur

Vexillary

Margin overlap

- Present in corolla of Fabaceae → Papilionaceous corolla)

Ex- Pea, Bean

SANKALP NEET VEDANTU

Parts of a Flower

Aestivation: The mode of arrangement of sepals or petals in floral bud with respect to the other members of the same whorl is known as aestivation.

cell theory

Parts of a Flower

Symbols – ⊕ - Actino

% – Zygo

$\underline{G}$ $\quad$ $\bar{G}$ – $\bar{\bar{G}}$

K_5

$K_{(5)}$

C_5

$C_{(5)}$

K_{2+2}

C_{2+2}

$K_{(2+2)}$

$C_{(2+2)}$

DOPA -03

Q1 Hypogynous ovary present in

(a) Rose (b) Cucumber (c) Peach (d) Aloe

Q2 Actinomorphic Flower

(a) Chinarose (b) Cassia (c) Arhar (d) Moong

Q3 Perianth present in — (a) Cotton (b) Okra (c) Mustard (d) Grass

Q4 twisted Aestivation — (a) Mustard (b) Pea (c) Cotton (d) Bean

Q5 Standard petal present in (a) Aloe (b) tulip (c) Okra (d) Soyabean

Q6 Gamopetelous present in (a) Pea (b) wheat (c) Solanum (d) Lily

Q7 Hypogynous Absent in (a) Mustard (b) Bean (c) Chinarose (d) Cucumber

Q8 Epigynous Flower — (a) Guava (b) Watermelon (c) Marigold (d) all

Q9 Imbricate Aestivation — (a) Calotropis (b) Cassia (c) Pea (d) Cotton

Q10 Perigynous Flower — (a) Plum (b) lotus (c) Rosaceae (d) all

Q11 Mustard & Pea similarity (a) Symmetery (b) Hypogynous (c) Vexillary (d) tetramerous

Q12 trimerous Flower in — (a) tulip (b) Maize (c) wheat (d) all

Q13 Gamosepalous & Gamopetalous condition in (a) Bean (b) Cabbage (c) Petunia (d) tulip

Q14 Not true About sunflower — (a) Racemose (b) Pentamerous (c) Epigynous (d) Hypogynous

Q15 Not true About china rose — (a) twisted (b) Pentamerous (c) Zygomorphic (d) Hypogynous

Q16 - Pea, Bean, Cucumber, Cabbage, Guava, Watermelon, Marigold

How many Hypogynous

(a) two (b) three (c) Four (d) Five

MANTHAN NEET 2025 - 1.0 & 2.0

SANKALP NEET VEDANTU

Morphology of Flowering plant

lecture - 04

Botany

TARUN SIR

Topics

no. of Question – 4Q

1. Inflorescence →
2. Flower →
3. Fruit & Seed
4. Family →

→ 3Q or 4Q

Root]
Stem]
leaf]

Structure + Modification → 1Q

Part delete

Important Examples

(Legumes Family)
Fabaceae → Gram, Arhar, moong, Sem, Bean, Soyabean, Groundnut
(Pea Family)
Sesbania, trifolium, Muliathi, Lupin, Sweet pea
indigofera, Sunhemp

Cruciferae
Brassicaceae → Mustard, Cabbage, Cauliflower, Radish
(Mustard Family)
turnip

Solanaceae – Potato, tomato, chilli, Brinjal, Makoi
Datura (Belladona), Ashwagandha, tobacco, Petunia

Dicot

Liliaceae → Lily, Onion (Allium cepa), Aloe, Asparagus
monocot
Colchicum, tulip, Gloriosa

SANKALP NEET VEDANTU

IV Malvaceae → Cotton, Lady Finger (Okra), China rose] Dicot

V Poaceae (Graminae) → Wheat, Rice, Oat (Avena sativa), Bamboo, Sugarcan, Maize, Grass] Monocot
(Wheat Family)
(Grass Family)

VI Asteraceae → Sunflower, Marigold] Dicot
(Sun flower)
(Compositaeae)

Q Sunflower, Mustard, Chilli, lily, Lupine, Aloe
Maize, Rice, Gram, Bean
Dicot – 6
Monocot – 4

SANKALP NEET VEDANTU

Inflorescence — Racemose → Brassicaceae, Fabaceae, Asteraceae, Poaceae
Cymose → Solanaceae, Liliaceae, Malvaceae

Symmetry → Actinomorphic Brassicaceae, Solanaceae, Liliaceae, Malvaceae
→ Zygomorphic → Fabaceae, Poaceae
→ Asymmetric – Canna

Isomery → tetra – Brassicaceae
→ trimerous → Poaceae, Liliaceae
→ Penta → Fabaceae, Solanaceae, Asteraceae, Malvaceae
→ Hypogynous → Bra, F, Solan, Lili, Poaceae, Malva

Epi – Asteraceae → Cucumber, Guava

Peri – R, P, P

Aestivation — valvate – calotropis — twisted – Co, Chin, Lq · Imbricate – Cas, Sup
Vexillary – Fabaceae

DOPA-02

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(a) Solanum (b) Lily (c) Cabbage (d) Cotton — C

S L B M

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fi Z

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Ri Li

(Asteraceae) (Poaceae)

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S. M.

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(x) (x)

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Q11 Few Ex-

F Sesbania, M cotton, M Chinarose, S Maize, F Muliathi, F Groundnut

F Lupin, M Lady Finger, P Wheat, P Maize, L lily, L tulip, Br Cabbage

Br Cauliflower, F Sunhemp

L+P
2 2

(a) Trimerous - 4 (d) Actino - 8 (g) Pentamerous - F+S+M = 9
5 1 3

Br (b) tetramerous = 2 (e) Zygo → 7 (F_S + P_2)

(c) Racemose = 9
Br+F+P
2 5 2

(f) Cymose → M+S+L = 6
3 1 2

4 2 9 8 7 6

cell theory

7. Placentation in which ovules develop on the inner wall of the ovary or in peripheral part, is (2019)

a. Basal

b. Axile

c. Parietal

d. Free central

DOPA -03

Q1 Hypogynous ovary present in

(a) Rose (P) (b) Cucumber (E) (c) Peach (P) (d) Aloe (liliaceae)

Q2 Actinomorphic Flower

(a) Chinarose (b) Cassia (Z) (c) Arhar (F) (Z) (d) Mung (F) (Z)

Q3 Perianth present in — (a) Cotton (Dicot) (b) Okra (c) Mustard (d) Grass (Mono

Q4 twisted Aestivation — (a) Mustard (b) Pea (c) Cotton (d) Bean

Q5 Standard petal present in (a) Aloe (b) tulip (c) Okra (d) Soyabean (F)

Q6 Gamopetelous present in (a) Pea (b) wheat (c) Solanum (d) lily

Q7 Hypogynous Absent in (a) Mustard (H) (b) Bean (H) (c) Chinarose (H) (d) Cucumber

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B F X

Q12 trimerous Flower in — (a) tulip (b) Maize (c) wheat (d) all (Mono)
P P

Q13 Gamosepalous & Gamopetalous condition in (a) Bean (b) Cabbage (c) Petunia (d) tulip
F B S

Q14 Not true About sunflower — (a) Racemose (b) Pentamerous (c) Epigynous (d) Hypogynous

Q15 Not true About china rose — (a) twisted (b) Pentamerous (c) Zygomorphic (d) Hypogynous
X X

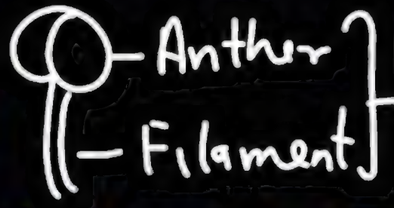
Q16 - Pea ✓, Bean ✓, Cucumber X, Cabbage ✓, Guava X, Water melon X, Marigold X

How many Hypogynous

(a) two (b) three (c) Four (d) Five

Androecium

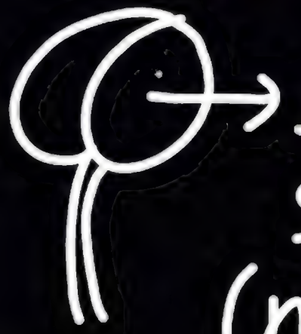
- Androecium - Group of stamens - Symbol = A



Stamen - male Reproductive organ

Anther → Bilobe → Each lobe two theca → convert into Pollen sac

Mature Anther ↓



→ Sterile → Staminode

Sterile Stamen (no pollen)

A 5 ⇒ 5 stamen

Androecium

Androecium is composed of stamens. Each stamen which represents the male reproductive organ consists of a stalk or a filament and an anther. Each anther is usually bilobed and each lobe has two chambers, the pollen-sacs. The pollen grains are produced in pollen-sacs. A sterile stamen is called **staminode**.

Androecium

Stamens of flower may be united with other members such as petals or among themselves. When stamens are attached to the petals, they are **epipetalous** as in brinjal, or **epiphyllous** when attached to the perianth as in the flowers of lily.

- Q Epipetalous condition present in
(a) Gynoecium (b) Androecium (c) Pistil (d) petal

Q epipetalous condition
(a) Mustard (b) Chinarose (c) tobacco (d) Lily

How stamen can Fuse → Two option

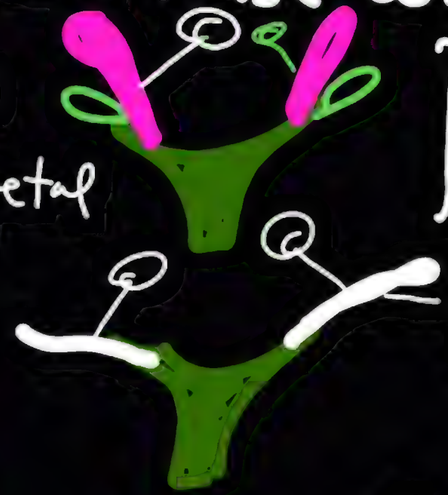
① Stamen Fuse with Member of other Whorl

② Stamen Fuse with other stamen - within whorl (same circle)

I When stamen Fuse with Member of other

(a) Epi petalous →

(Stamen Fuse with petal



tepal

} Solanaceae Ex - Brinjal ⊕ ♀ $K_{(5)}$ $\overset{\frown}{C_{(5)}}$ A_5

(b) Epiphyllous

(Stamen Fuse with member of Perianth

} liliaceae Ex - lily ⊕ ♀ $\overset{\frown}{P_{(3+3)}}$ A_{3+3}

when stamen Fuse with member of same whorl

(a) Stamen Free – Attach on thalamus

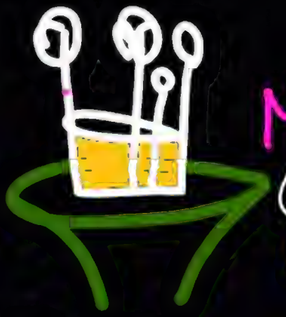
– Polyandrous

(b) Stamen Can be Fuse

Anther Fuse (Filament Free) Syngenisions-Sunflower

(Anther Free) Filament Fuse Delphous

Anther Fuse Filament Fuse



Monodelphous (Single whorl) Ex– China rose

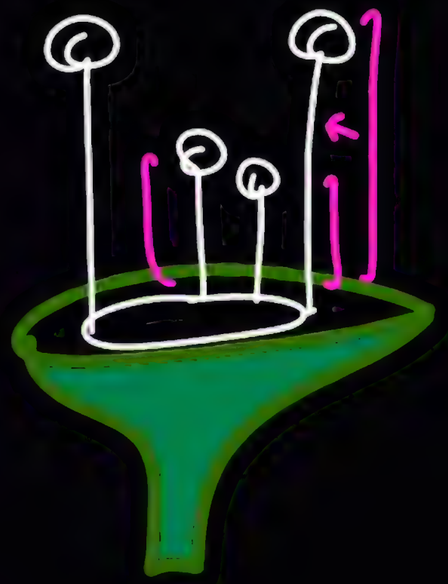
Diadelphous – A(9)+1 (two whorl) Ex– Pea

Polydelphous Ex– Citrus

Androecium

- Stamen length Different - due to Filament length Different

(Unequal stamen → Mustard (Brassicaceae)
Salvia



① Staminode — sterile sta

② Epipetalous — Stamen Fuse with petal - Ex- Brinjal — Solanaceae

③ Epiphyllous - Stamen Fuse with perianth - Ex Lily — Liliaceae

④ Polyandrous - Stamen Free

⑤ Monodelphous - Filament Fuse in one whorl - Ex- China rose → Malvaceae

⑥ Diadelphous - Filament Fuse in two whorls → Ex - Pea — Fabaceae

⑦ Polydelphous — Filament Fuse in many whorl Ex - Citrus

⑧ Syngenisious → Ex - Sunflower

⑨ Unequal stamen → Ex - Salvia, Mustard (Brassicaceae)

Q Unequal stamen ⟶ Salvia & Brassica

(a) Lily (b) Cabbage (c) Aloe (d) Pea

Q2 Monodelphous

(a) Bean (b) Petunia (c) cotton (d) tulip

F S M L

Q Few Ex - Given - cotton(M), Lily(L), indigofera(F), Sunflower(A), Marigold(A), Chinarose(M), Bean(F), tobacco(S), Aloe(L), Malvi(S), tomato(S), Asparagus(L), Cabbage(B), turnip(B)

S (a) Epipetalous - 3 (c) Unequal stamen (B) → 2 (f) Syngenisious 2

L (b) Epiphyllous - 3 (d) Monadelphous → 2

(e) Didelphous → 2

Androecium

as in the flowers of lily. The stamens in a flower may either remain free (polyandrous) or may be united in varying degrees. The stamens may be united into one bunch or one bundle **(monoadelphous)** as in china rose, or two bundles **(diadelphous)** as in pea, or into more than two bundles **(polyadelphous)** as in citrus. There may be a variation in the length of

M →
D →
P →

Gynoecium — Whorl of Carpel — Symbol – G

G

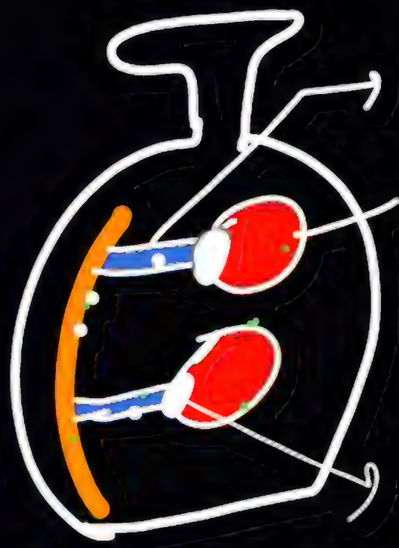
– Female Reproductive organ → Pistil or Carpel

– Stigma – landing platform For pollen

– Style – hollow, tube like structure, top of which Stigma present

– ovary – Basal Bulge Part, ovary have Flat tissue – Placenta

On Placenta – ovule develop



5.5.1.4 Gynoecium

Gynoecium is the female reproductive part of the flower and is made up of one or more carpels. A carpel consists of three parts namely stigma, style and ovary.

5.5.1.4 Gynoecium

stigma, style and ovary. **Ovary** is the enlarged basal part, on which lies the elongated tube, the style. The style connects the ovary to the stigma. The **stigma** is usually at the tip of the **style** and is the receptive surface for pollen grains. Each ovary bears one or more ovules attached to a flattened, cushion-like **placenta**. When more

ovules attached to a flattened, cushion-like **placenta**. When more than one carpel is present, they may be free (as in lotus and rose) and are called **apocarpous**. They are termed **syncarpous** when carpels are fused, as in mustard and tomato. After fertilisation, the ovules develop into seeds and the ovary matures into a fruit.

I Number of carpel

(a) Monocarpellary - Thalamus single → Carpel

G1

(two option)

Single ovule → Single seed - Ex- Mango

Many ovule → Many seed - Ex- Pea Fabaceae

(b) Bicarpellary →

[Carpel Fuse = Syncarpus

G(2) Ex- tomato, Mustard (Brassicaceae) (Solanaceae)

(Apocarpus) - G2 - Ex Rose, lotus

Carpel Free]

(c) Tricarpellary → Lily → tricarpellary Syncarpus → G(3)

Liliaceae

(d) Multicarpellary → Apocarpus - Ex- Michelia (A|M)

→ Syncarpus - Ex- Papaver

(Class-12th)

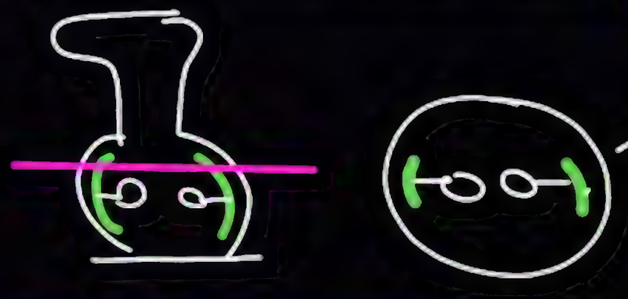
true for pea

(a) G(1) (b) G1

(b) G(2) (d) G1

Placentation – Arrangement of ovule on placenta inside ovary

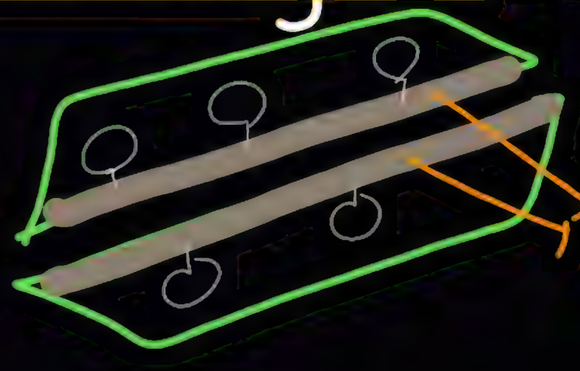
(also observed in Fruit – Seed Arrangment)



→ Diagramme Draw

Type of placentation
(a) Marginal
(b) Axile
(c) Free central
(d) Parietal
(e) Basal

(a) Marginal → Ex- Pea (Fabaceae)



– on ventral Suture – Ridge present on which placenta present } Definition

(b) Axile – placenta Axial, ovary is **Multilocular**

Ex – le, chin, to

lemon → China rose – Malvaceae

to – tomato – Solanaceae

((iliaceae also have Axile)

(d) Parietal → Placenta is in inner wall of ovary, False septum

Arg My

↓ Argemone

↓ Mustard (Brassicaceae)

(c) Free central → placenta central

Unilocular ovary

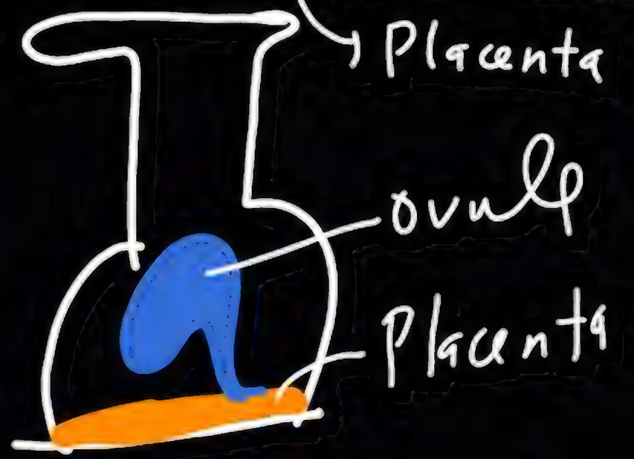
Ex – Di pri

↓ Dianthus

↓ Primerose

(e) Basal → Placenta

Ex – Sunflower, Wheat at Base of ovary Single ovule



Marginal

Ex - Pea
Ventral Suture - Ridge - Placenta

Axile

Le, Chin, To
Liliaceae

→ Multilocular ovary

Free central

Di Pri → Unilocular

Parietal

Arg Mu → Inner wall of ovary
False septum

Basal

Marigold, Sunflower
Wheat

→ Base of ovary - Placenta

21. The term 'Polyadelphous' is related to: (2016 - II)

a. Corolla b. Calyx

c. Gynoecium d. Androecium

24. Tricarpellary, syncarpous gynoecium is found in flowers of: (2016 - I)

a. Liliaceae

b. Solanaceae

c. Fabaceae

d. Poaceae

25. The standard petal of a papilionaceous corolla is also called: (2016 - I)

a. Carina
b. Pappus
c. Vexillum
d. Corona

5. Which of the following is the correct floral formula of Liliaceae? — Perianth (2020 Covid Re-NEET)

a. $\oplus \delta \varphi K_{(5)} \overset{\frown}{C_{(5)} A_5} \underline{G}_{(2)}$

b. Br $\oplus \varphi \overset{\frown}{\underline{P}_{(3+3)} A_{3+3}} G_{(3)}$

c. $\oplus \varphi K_{(5)} \overset{\frown}{C_{(5)} A_5} \underline{G}_{(2)}$

d. % $\varphi C_{1+2+(2)} A_{(9)+1} \underline{G}_{(1)}$

Cell theory

7. Placentation in which ovules develop on the inner wall of the ovary or in peripheral part, is (2019)

a. Basal

b. Axile

c. Parietal

d. Free central

16. Tetradynamous stamens are characteristic of: (2017-Gujarat)

a. Brassicaceae
b. Solanaceae
c. Fabaceae
d. Liliaceae

cell theory

18. Free-central placentation is found in: (2016 - II)

a. *Brassica* – Parietal

b. *Citrus* – Axile

c. *Dianthus* (c)

d. *Argemone* – Parietal

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19. Radial symmetry is found in the flowers of: (2016 - II)

a. *Pisum*

b. *Cassia*

c. *Brassica*

d. *Trifolium*

20. How many plants among *Indigofera*, *Sesbania*, *Salvia*, *Allium*, Aloe, mustard, groundnut, radish, gram and turnip have stamens with different lengths in their flowers? (2016 - II)

Onion

Unequal stamen + Mustard Salvia

a. Five

b. Six

c. Three

d. Four (d)

27. Keel is the characteristic feature of flower of: (2015)

a. Aloe — L
b. Tomato — S
c. Tulip — L
d. *Indigofera* F

28. Perigynous flowers are found in: (2015)

a. China rose — H
b. Rose
c. Guava — E
d. Cucumber E

29. Ovary is inferior in: E (2015)

a. Guava E
b. Rose P
c. China rose H
d. Peach P

30. Flowers are unisexual in: (2015 Re)

a. Cucumber
b. China rose — ♀♂
c. Onion ♀♂
d. Pea ♀♂

32. Axile Placentation is present in: (2015 Re)

a. Lemon 32 - 9 b. Pea - Marginal

c. *Argemone* Parietal d. *Dianthus* - Free

33. Among china rose, mustard, brinjal, potato, onion and tulip, how many plants have superior ovary? (H) (2015 Re)

a. Six b. Three c. Four d. Five

47. How many plants in the list given below have composite fruits that develop from an inflorescence?

Walnut, poppy, radish, fig, pineapple, apple, tomato, mulberry. (2012 Pre)

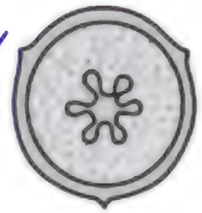
a. Three b. Four c. Five d. Two

48. Which one of the following diagrams represents the placentation in *Dianthus*? — Free cen (2011 Mains)

a. Marg

b. Parietal

c. Axile

d.  Free cen

DOPA-04

Q1 Free central placentation (a) Primrose (b) Pea (c) Cabbage (d) Mustard

Q2 Placentation in Sweet pea (a) Marginal (b) Free central (c) Basal (d) Axile

Q3 Axile placentation present in (a) Lily (b) Lemon (c) Cotton (d) all

Q4 Basal placentation — (a) Bean (b) Brassica (c) Marigold (d) Raddish

Q5 Epipetalous condition — (a) Sunflower (b) Ashwagandha (c) tulip (d) lupine

Q6 Epiphyllous condition → (a) tulip (b) Gloriosa (c) Lily (d) all

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Q9 Racemon inflorescence (a) Solanum (b) Chinarose (c) Cabbage (d) Cotton

Q10 Imbricate Aestivation - (a) Cassia (b) Gulmohur (c) Pea (d) Both a & b

Q11 Vexillary Aestivation – (a) Sunhemp (b) Sesbania (c) Arhar (d) all

Q12 Lemon, Mustard, chilli, Solanum, pea – How many Axil – (a) one (b) two (c) three (d) Four

Q13 Mustard & cotton Similarity (a) Placentation (b) Superior ovary (c) tetramerous (d) Unequal Stamen

Q14 Unequal stamen present in → (a) Raddish (b) Bean (c) Solanum (d) Chilli

Q15 Pea and Chilli have similarity (a) Placentation (b) Symmetry (c) Hypogynous (d) Vexillary

Q16 Not true About china rose (a) Axile (b) Hypogynous (c) Imbricate (d) twisted

Q17 Not true About pea (a) Marginal (b) Bilateral (c) Epigynous (d) Vexillary

Q18 Not true About Chilli (a) Axile (b) Epipetalous (c) Pentamerous (d) Zygomorphic

Q19 Not true About wheat (a) Basal (b) Racemose (c) Monocot (d) Pentamerous

Q20 Not true About Lily (a) trimerous (b) Epiphyllous (c) Basal (d) Monocot

50. Flowers are zygomorphic in: (2011 Pre)

a. *Datura* b. Mustard

c. Gulmohur d. Tomato

51. The ovary is half inferior in flowers of: (2011Pre)

a. Guava b. Peach

c. Cucumber d. Cotton

52. A drupe develops in: (2011 Pre)

a. Tomato b. Mango

c. Wheat d. Pea

53. The correct floral formula of chili is: (2011 Pre)

a. $\oplus \female K_5 \overset{\curvearrowleft}{C_5} A_{(5)} G_{(2)}$ b. $\oplus \female K_{(5)} C_5 A_5 G_{(2)}$

c. $\oplus \female K_{(5)} \overset{\curvearrowleft}{C_{(5)}} A_5 G_{(2)}$ d. $\oplus \female K_{(5)} C_{(5)} A_{(5)} G_2$

MANTHAN NEET 2025 - 1.0 & 2.0

SANKALP NEET VEDANTU

Morphology of Flowering plant

lecture - 05

Botany

TARUN SIR

Topics

no. of Question – 4Q

1. Inflorescence →
2. Flower →
3. Fruit & Seed
4. Family →

→ 3Q or 4Q

Root]
Stem]
leaf]

Structure + Modification → 1Q

Part delete

cell theory

Important Examples

(Legumes Family)
Fabaceae → Gram, Arhar, moong, Sem, Bean, Soyabean, Groundnut
(Pea Family)
Sesbania, trifolium, Muliathi, Lupin, Sweet pea
indigofera, Sunhemp

Cruciferae
Brassicaceae → Mustard, Cabbage, Cauliflower, Radish
(Mustard Family)
turnip

Solanaceae – Potato, tomato, chilli, Brinjal, Makoi
Datura (Belladona), Ashwagandha, tobacco, Petunia

Dicot

Liliaceae → Lily, Onion (*Allium cepa*), Aloe, Asparagus
monocot
Colchicum, tulip, Gloriosa

IV Malvaceae → Cotton, Lady Finger (Okra), China rose] Dicot

V Poaceae (Graminae) → Wheat, Rice, Oat (Avena sativa), Bamboo, Sugarcan, Maize, Grass] Monocot
(Wheat Family)
(Grass Family)

VI Asteraceae → Sunflower, Marigold] Dicot
(Sunflower)
(Compositaeae)

Q Sunflower (D), Mustard (D), Chilli (D), lily (M), Lupine (D), Aloe (M)
Maize (M), Rice (M), Gram (D), Bean (D)

Dicot – 6
Monocot – 4

cell theory

Inflorescence — Racemose → Brassicaceae, Fabaceae, Asteraceae, Poaceae
Cymose → Solanaceae, Liliaceae, Malvaceae

Symmetry → Actinomorphic Brassicaceae, Solanaceae, Liliaceae, Malvaceae
→ Zygomorphic + Fabaceae, Poaceae
→ Asymmetric – Canna

Isomery → tetra – Brassicaceae
→ trimerous → Poaceae, Liliaceae
→ Penta + Fabaceae, Solanaceae, Asteraceae, Malvaceae
→ Hypogynous → Bra, F, Solan, Lili, Poaceae, Malvaceae

Epi – Asteraceae → Cucumber, Guava

Peri – R, P, P

Aestivation — valvate – calotropis — twisted – Co, Chin, Lq · Imbricate – Cas, Sap
Vexillary – Fabaceae

24. Tricarpellary, syncarpous gynoecium is found in flowers of: (2016 - I)

a. Liliaceae

b. Solanaceae

c. Fabaceae

d. Poaceae

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cell theory

25. The standard petal of a papilionaceous corolla is also called:

(2016 - I)

a. Carina

b. Pappus

c. Vexillum

d. Corona

cell theory

34. An aggregate fruit is one which develops from: (2014)

a. Multicarpellary superior ovary

b. Multicarpellary syncarpous gynoecium

c. Multicarpellary apocarpus gynoecium

d. Complete inflorescence

35. Which one of the following statements is correct? (2014)

a. A sterile pistil is called a staminode

b. The seed in grasses is not endospermic

c. Mango is a parthenocarpic fruit

d. A proteinaceous aleurone layer is present in maize grain

36. When the margins of sepals or petals overlap one another without any particular direction, the condition is termed as: (2014)

a. Valvate

b. Vexillary

c. Imbricate

d. Twisted

44. Cymose inflorescence is present in: (2012 Pre)

a. *Brassica* b. *Solanum*

c. *Sesbania* d. *Trifolium*

45. Vexillary aestivation is characteristic of the family: (2012 Pre)

a. Brassicaceae b. Fabaceae

c. Asteraceae d. Solanaceae

cell theory

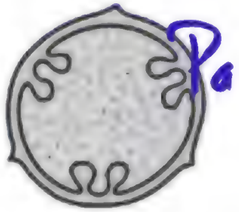
47. How many plants in the list given below have composite fruits that develop from an inflorescence?

Walnut, poppy, radish, fig, pineapple, apple, tomato, mulberry. (2012 Pre)

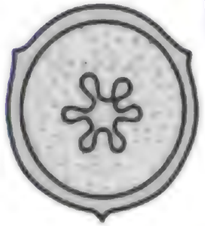
a. Three b. Four c. Five d. Two

48. ~~Which one of the following diagrams represents the placentation in *Dianthus*?~~ (~~2011 Mains~~)

a.

b. 

c.

d. 

41. In China rose the flowers are: (2013)

a. Zygomorphic, epigynous with twisted aestivation

b. Actinomorphic, hypogynous with twisted aestivation

c. Actinomorphic, epigynous with valvate aestivation

d. Zygomorphic, hypogynous with imbricate aestivation

cell theory

DOPA-04

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c. $\oplus \female K_{(5)} \overset{\curvearrowleft}{C_{(5)}} A_5 G_{(2)}$ d. $\oplus \female K_{(5)} C_{(5)} A_{(5)} G_2$

Summary

	Brassicaceae	Fabaceae	Solanaceae	Liliaceae	Malvaceae	Asteraceae	Poaceae
Dicot or Monocot	D	D	D	M	D	D	M
Inflorescence	R	R	C	C	C	R	R
Symmetry	A	Z	A	A	A	A – Dic Z – Ray	Z
Isomery →	Tetra	P	P	Tri	P	P	tri
ovary →	H	H	H	H	H	E	H
Aestivation	–	Vexillary	–	–	twisted	–	–
Androecium	Unequal stamen	Diadelphous	Epipetalous	Epiphyllous	Monadelphous	Syngenisious	–
Gynoecium	G(2)	G1	G(2)	G(3)	–	–	–
Placentation →	Parietal	Marginal	Axile	Axile	Axile	Basal	Basal

Summary

	Brassicaceae	Fabaceae	Solanaceae	Liliaceae	Malvaceae	Asteraceae	Poaceae
KW							

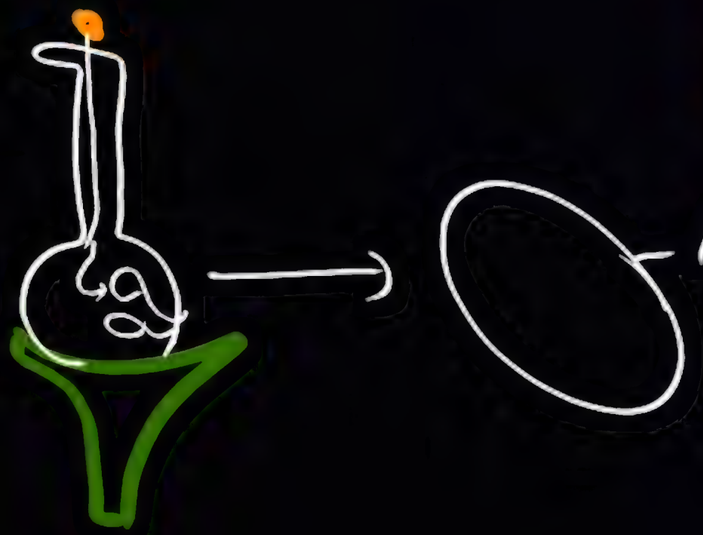
Summary

	Brassicaceae	Fabaceae	Solanaceae	Liliaceae	Malvaceae	Asteraceae	Poaceae

Fruit

→ only Angiosperm develops Fruit

→ Fruit is a Ripened ovary develop after Fertilization



→ Ovary wall → Pericarp

→ Fruit wall → Pericarp

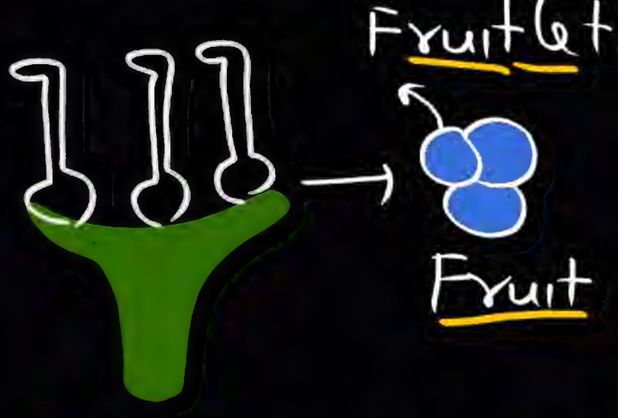
→ After Pollination & Fertilization → Auxin level Inc. → ovary convert into Fruit

Type of Fruit

Three type of Fruit

(a) Simple Fruit →
- From monocarpellary
- Syncarpus ovary
(more than one carpel)

Ex- Mustard, Pea, Solanum, Lily



(b) Aggregate Fruit
- Multicarpellar or Bicarpellary (Apocarpus) Rosaceae

Ex- Custard Apple, Blackberry, Raspberry, Strabeery

(c) Composite Fruit develop From inflorenu

Ex- Pineapple ✓
→ Jack Fruit ✓
→ Mulberry
→ Banyan, Peepal, Fig

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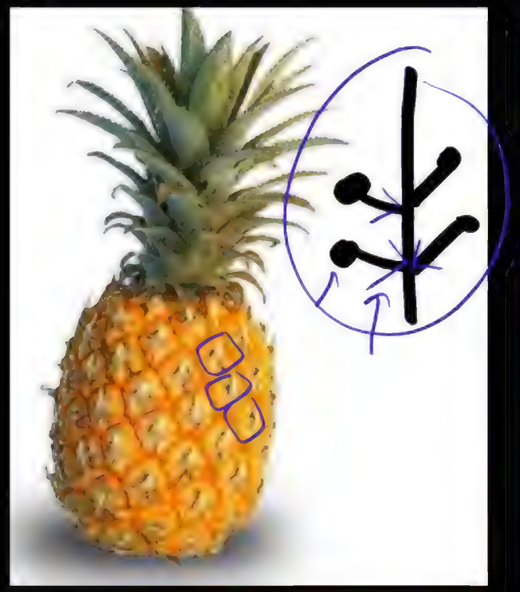
Q Simple fruit

(a) Mustard (b) Lily (c) tomato (d) Pea

G(2) G(3) G(2)

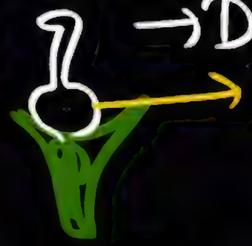
Syncarpy

Fruit



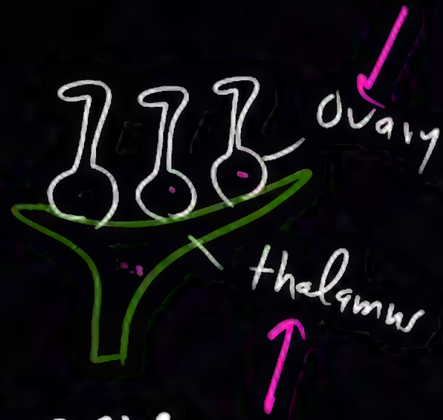
Type of Fruit — on the Basis of development

(a) True Fruit → (Eucarp) → Develop From ovary



(b) False Fruit (Pseudocarp) → thalamus also involve in Fruit Formation

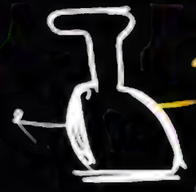
Ex- Apple, Cashew, Strawberry



(c) Parthenocarpic (Seed less Fruit) → Without Fertilization Auxin level increase

And Fruit develop without seed Ex- Banana

Classification of Fruit (Simple Fruit)



Dry Fruit
- Pericarp not Divisible into layers

Dehiscent | Can open
Ex- Pea (legume)
→ Mustard

Indehiscent
- not open

Ex- Wheat (Fruit is known as Caryopsis
Maize

Fleshy | Succulents
- Pericarp Divisible into three layer (Epicarp, mesocarp, Endocarp)
(all three, one or two layer can Edible)

Fleshy Fruit

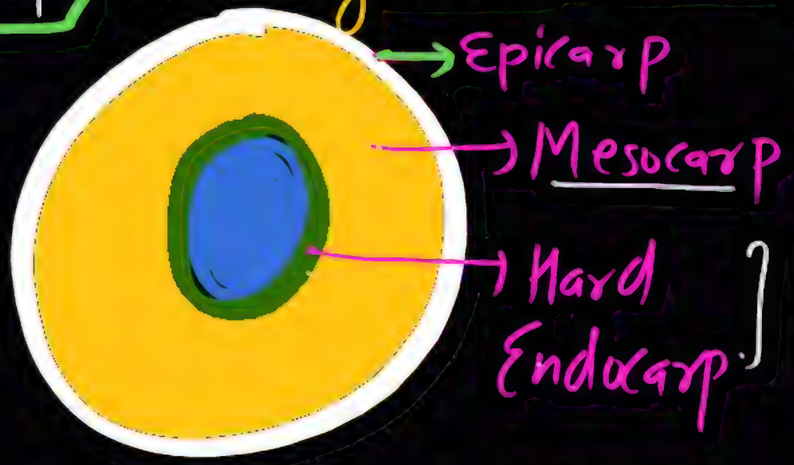
- Pericarp divisible into Epicarp, mesocarp & Endocarp

Example of Fleshy Fruit

(a) Berry → Ex - tomato — Entire Pericarp (Epi, Meso, Endo) + Placenta Edible

(b) Pome → Ex - Apple

(c) Drupe → Single seed, Hard (stony) Endocarp — Ex - Mango - mesocarp Edible
Coconut - Endosperm Edible
(coir) → Hair - Mesocarp
Hard - Endocarp
Seed = one



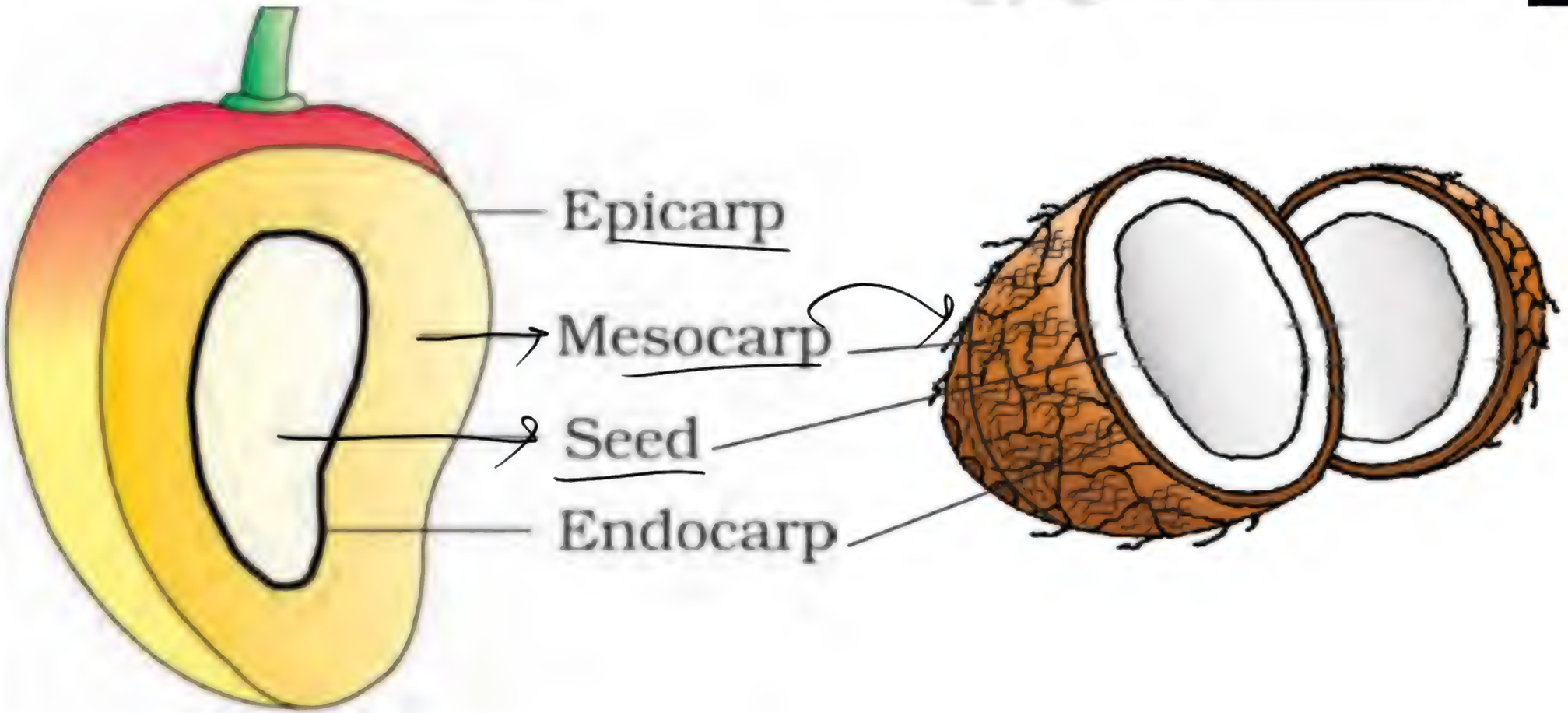
Mango → Single seed

Both coconut & Mango → develop From monocarpellary Superior ovary

The fruit is a characteristic feature of the flowering plants. It is a mature or ripened ovary developed after fertilisation. If a fruit is formed without fertilisation of the ovary, it is called a **parthenocarpic** fruit.

Generally, the fruit consists of a wall or **pericarp** and seeds. The pericarp may be dry or fleshy. When pericarp is thick and fleshy, it is differentiated into the outer **epicarp**, the middle **mesocarp** and the inner **endocarp**.

outer thin epicarp, a middle fleshy edible mesocarp and an inner stony hard endocarp. In coconut which is also a drupe the mesocarp is fibrous.



Seed development After Fertilization

(Primary Endosperm cell)

PEC – 3n

Zygote

Inside ovule

(Role – Provide nutrition to Embryo

Endosperm

Zygote → From Embryo

Endosperm Give Food to Embryo (inside cotyledon)

cotyledon (Food)

Embryonal Axis

Embryo

Embryo less Food

Endosperm Seed (Endospermous)

Embryo – Food present

Endosperm – Use (Absent)

Seed (non-Endospermous)

Seed

→ Seed is a Fertilised ovule develop after Fertilization

→ Seed ⟶ parts → (a) Seed coat → outer testa, Inner tegmen (Dicot)

(b) Embryo → Embryonal Axis, Cotyledon

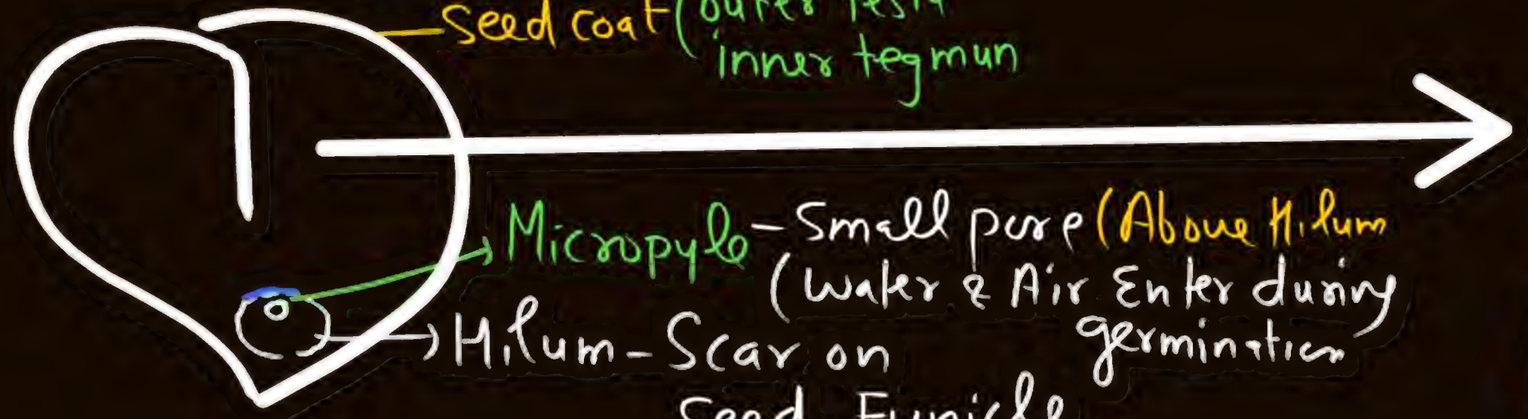
(c) Endosperm (Some seed) — Present in monocot seed

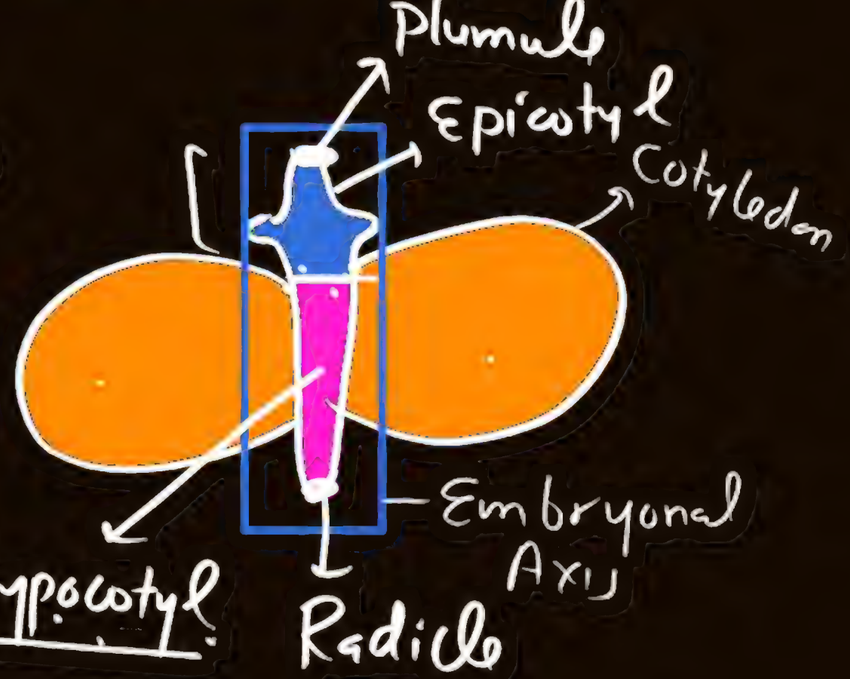
→ testa
→ tegmen
] Seed coat (develop From integument)

→ Embryo → Cotyledon - Food Reserve
→ Embryonal Axis

Dicot seed

– Example – Gram, Pea → Endosperm Absent
Food in cotyledon





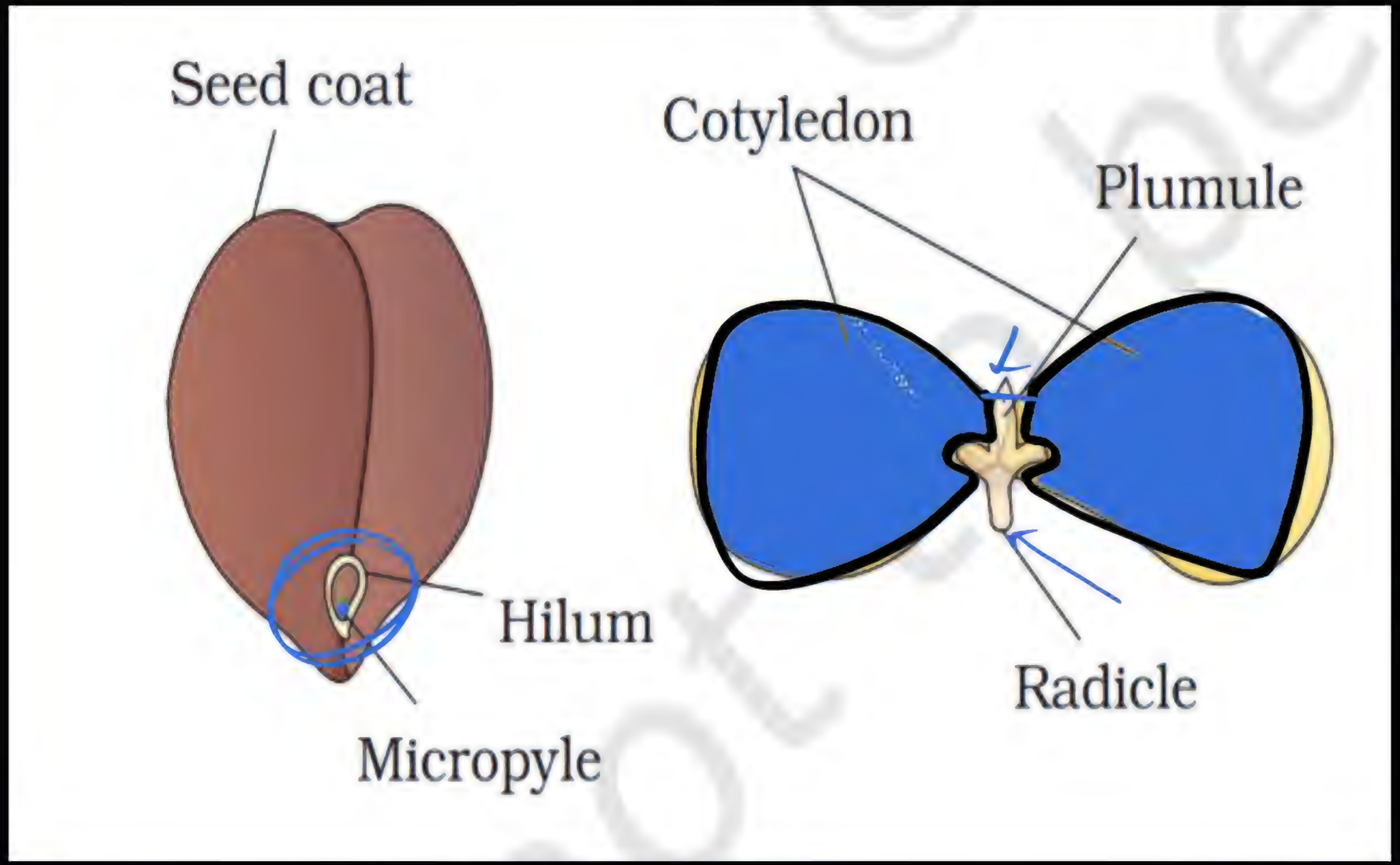
Embryo
- Cotyledon – Food Reserve
- Embryonal Axis
  - Epicotyl → tip is Plumule → Give shoot
  - hypocotyl → tip is Radicle → Give Root

seed

The ovules after fertilisation, develop into seeds. A seed is made up of a seed coat and an embryo. The embryo is made up of a radicle, an embryonal axis and one (as in wheat, maize) or two cotyledons (as in gram and pea).

monocot - 1

Dicot


Seed coat
Hilum
Micropyle
Cotyledon
Plumule
Radicle

5.7.1 Structure of a Dicotyledonous Seed

The outermost covering of a seed is the seed coat. The seed coat has two layers, the outer **testa** and the inner **tegmen**. The **hilum** is a scar on the seed coat through which the developing seeds were attached to the fruit.

Above the hilum is a small pore called the **micropyle**. Within the seed coat is the embryo, consisting of an embryonal axis and two cotyledons. The cotyledons are often fleshy and full of reserve food materials. At the two ends of the embryonal axis are present the radicle and the plumule (Figure 5.14). In some seeds such

full of reserve food materials. At the two ends of the embryonal axis are present the radicle and the plumule (Figure 5.14). In some seeds such as castor the **endosperm** formed as a result of double fertilisation, is a food storing tissue and called endospermic seeds. In plants such as bean, gram and pea, the endosperm is not present in mature seeds and such seeds are called non-endospermous.

Endospermous and non-Endospermous

→ All Dicot → Cotyledon well develop → Seed Endosperm → Non-Endospermous
Absent

(Exception → Castor
Solanaceae)

Ex - Pea, Bean, Mustard
(Dicot - non-Endospermous)

→ All monocots are Endospermous
(Cotyledon not well develop)

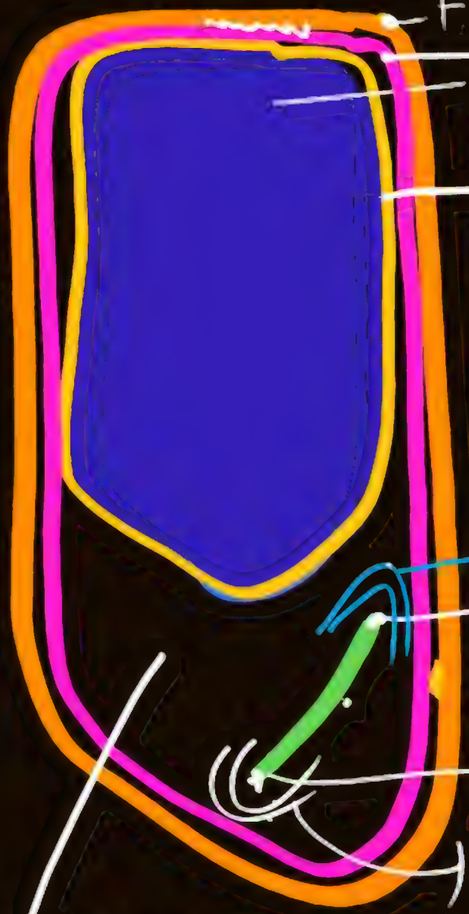
Ex - Wheat, maize, Sugarcane
Coconut, Lily Family

Exception - Orchid - is a monocot
But non-Endospermous)

structure of monocot seed

Ex- Wheat maize

monocot → liliaceae, Poaceae (Grass Family)



- Fruitwall
- Seed coat } Fruit wall & Seed coat - Fuse
- Endosperm (Food Store)
- → Aleurone layer (protein) → Enzyme
- coleoptile
- → Plumule
- → Radicle
- Coleorhizae
- → Cotyledon → In Grass Family - Scutellum

Maize seed → Seed coat & Fruit wall (Pericarp) Fuse

→ Endosperm - bulky & Aleurone layer (Protein) Surround Endosperm

→ Embryonal Axis
- → Plumule → tip of Epicotyl
  - hollow leaf like structure
  - Cover → Coleoptile
- → Radicle + tip of hypocotyl
  - Hollow sheath cover - Coleorhiza

— In Grass Family - Cotyledon Shield Shape — Scutellum

DOPA-05

Q1 hypogynous ovary present in – (a) Cucumber (b) Watermelon (c) Sunflower (d) cotton

Q2 Syncarpus ovary present in (a) Mustard (b) Chilly (c) lily (d) all

Q3 Apocarpus ovary – (a) Rose (b) lotus (c) Plum (d) all

Q4 Aggregate Fruit → (a) Apocarpus ovary (b) Syncarpus ovary (c) Monocarpellary (d) inflorescence

Q5 Seed less Fruit present in (a) Cotton (b) Banana (c) Cashew (d) Apple

Q6 thalamus Edible in (a) Pea (b) Strawberry (c) tomato (d) Mustard

Q7 Composite Fruit present in (a) Fig (b) Strawberry (c) tomato (d) Mustard

Q8 Fruit develop From inflorescence (a) Simple (b) Composite (c) true (d) Aggregate

Q9 Mango Fruit is (a) Fleshy (b) Drupe (c) true Fruit (d) all

Q10 Pericarp not Differentiate in – (a) Mango (b) tomato (c) Pea (d) coconut

Q11 Endospermous seed - (a) Coconut (b) Maize (c) Caster (d) all

Q12 Non Endospermous seed → (a) Pea (b) Bean (c) Groundnut (d) all

Q13 Dicot seed which is Endospermous → (a) Aloe (b) Maize (c) Caster (d) orchid

Q14 Plamule is part of (a) Cotyledon (b) Seed coat (c) Embryonal Axid (d) Endosperm

Q15 Grass Family not Feature (a) Scutellum (b) Coleoptile (c) Non-Edospermous (d) Coleorhizae

Q16 Scar on Gram seed is (a) Funicle (b) Hilum (c) Micropyle (d) all

Q17 Fleshy Fruit is present in (a) Mustard (b) Mango (c) Bean (d) Pea

Q18 dehischent Fruit is present in (a) Poaceae (b) Solanaceae (c) Fabaceae (d) all

Q19 Caryopsis is Fruit of (a) Sunflower (b) Pea (c) Maize (d) all

Q20 Shield shape cotyledon (a) all Monocot (b) Dicot (c) Grass Family (d) all non Endospermous seed

cell theory

MANTHAN NEET 2025 - 1.0 & 2.0

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Morphology of Flowering plant

lecture - 06

Botany

TARUN SIR

Topics

no. of Question – 4Q

1. Inflorescence →
2. Flower →
3. Fruit & Seed
4. Family →

→ 3Q or 4Q

Root]
Stem]
leaf]

Structure + Modification → 1Q

Part delete

cell theory

Important Examples

(Legumes Family)
Fabaceae → Gram, Arhar, moong, Sem, Bean, Soyabean, Groundnut
(Pea Family)
Sesbania, trifolium, Muliathi, Lupin, Sweet pea
indigofera, Sunhemp

Cruciferae
Brassicaceae → Mustard, Cabbage, Cauliflower, Radish
(Mustard Family)
turnip

Solanaceae – Potato, tomato, chilli, Brinjal, Makoi
Datura (Belladona), Ashwagandha, tobacco, Petunia

Dicot

Liliaceae → Lily, Onion (*Allium cepa*), Aloe, Asparagus
monocot
Colchicum, tulip, Gloriosa

IV Malvaceae → Cotton, Lady Finger (Okra), China rose] Dicot

V Poaceae (Graminae) → Wheat, Rice, Oat (Avena sativa), Bamboo, Sugarcan, Maize, Grass] Monocot
(Wheat Family)
(Grass Family)

VI Asteraceae → Sunflower, Marigold] Dicot
(Sunflower)
(Compositaeae)

Q Sunflower (D), Mustard (D), Chilli (D), lily (M), Lupine (D), Aloe (M)
Maize (M), Rice (M), Gram (D), Bean (D)

Dicot – 6
Monocot – 4

cell theory

Inflorescence — Racemose → Brassicaceae, Fabaceae, Asteraceae, Poaceae
Cymose → Solanaceae, Liliaceae, Malvaceae

Symmetry → Actinomorphic Brassicaceae, Solanaceae, Liliaceae, Malvaceae
→ Zygomorphic + Fabaceae, Poaceae
→ Asymmetric – Canna

Isomery → tetra – Brassicaceae
→ trimerous → Poaceae, Liliaceae
→ Penta + Fabaceae, Solanaceae, Asteraceae, Malvaceae
→ Hypogynous → Bra, F, Solan, Lili, Poaceae, Malvaceae

Epi – Asteraceae → Cucumber, Guava

Peri – R, P, P

Aestivation — valvate – calotropis — twisted – Co, Chin, Lq · Imbricate – Cas, Sap
Vexillary – Fabaceae

Summary

	Brassicaceae	Fabaceae	Solanaceae	Liliaceae	Malvaceae	Asteraceae	Poaceae
Dicot or Monocot	D	D	D	M	D	D	M
Inflorescence	R	R	C	C	C	R	R
Symmetry	A	Z	A	A	A	A – Dic Z – Ray	Z
Isomery →	Tetra	P	P	Tri	P	P	tri
ovary →	H	H	H	H	H	E	H
Aestivation	–	Vexillary	–	–	twisted	–	–
Androecium	Unequal stamen	Diadelphous	Epipetalous	Epiphyllous	Monadelphous	Syngenisious	–
Gynoecium	G(2)	G1	G(2)	G(3)	–	–	–
Placentation	Parietal	Marginal	Axile	Axile	Axile	Basal	Basal

Summary

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Q20 Shield shape cotyledon (a) all Monocot (b) Dicot (c) Grass Family (d) all non Endospermous seed

5.1 The Root

Basic Feature

(a) Vegetative part

(b) develop From Radicle

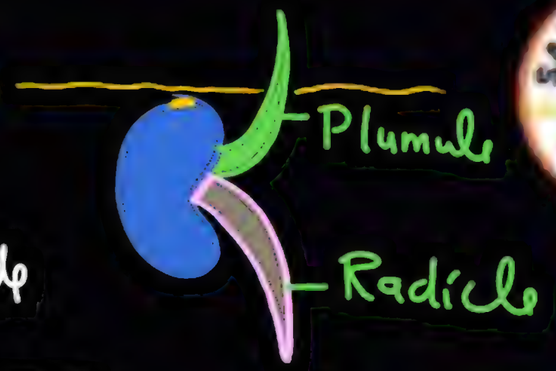
(c) node & internode Absent

(d) Root branch – Endogenous

(e) Root → Positive Geotropic (Root move towards Gravity & water) Negatively Phototropic.
Positive Hydropic

(f) Root – Chloroplast Absent (Root is non-green)

Stem = Exogenous
Branch ↗



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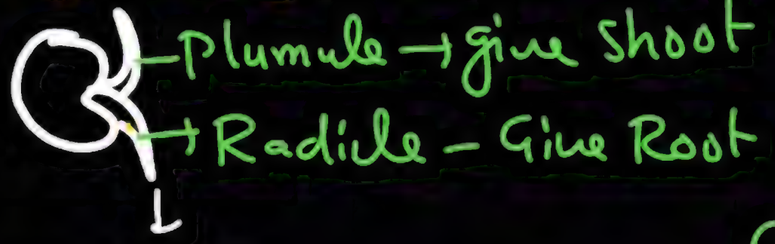
Root system – Inside soil → Root, Root Branch & Root hair

Two type of Root system

I Tap Root system →



- From Radicle Primary Root develop & Persisting (stay Alive)

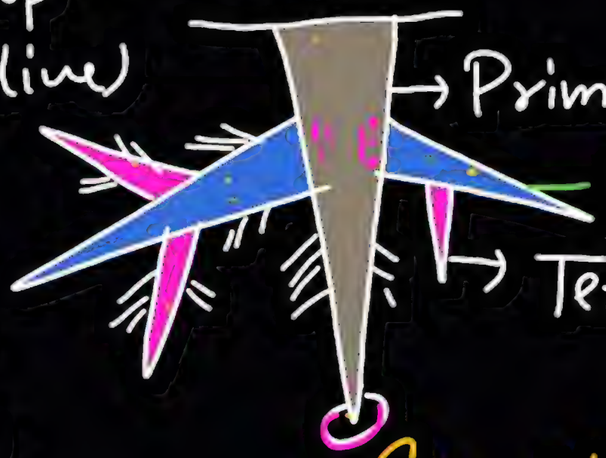
→ From primary Root, Root of Different order develop

(Grow vertically Downward)

→ Primary Root – develop From Radicle

Secondary Root (Grow at some Angle)

→ Tertiary Root (towards water)



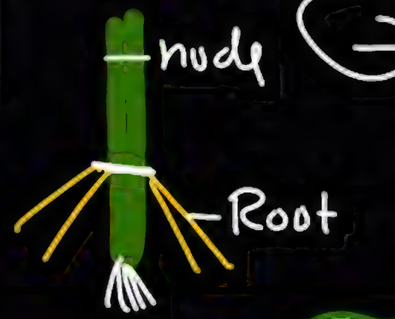
Example – Mustard (Dicot)

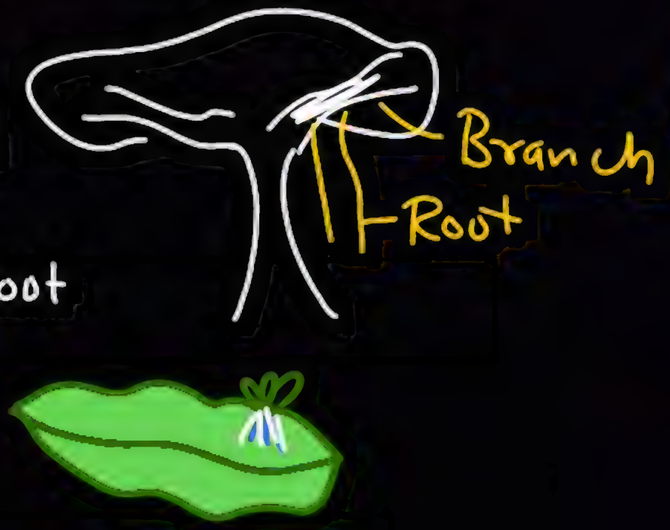
(Pea, Solanum, Mustard)

Adventitious Root system

→ Root develop other than Radicle

Ex- From node, From Branch, From leaf

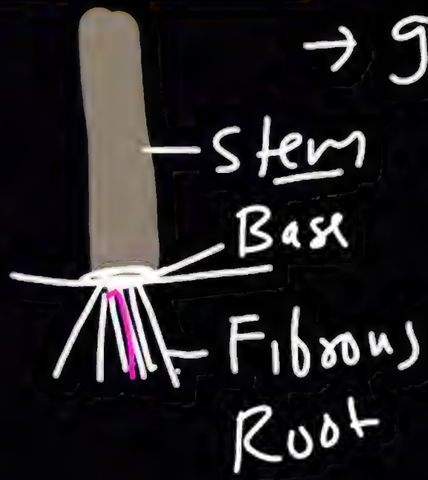




Fibrous Root - Type of Adventitious Root

→ It develop From Base of stem

(Primary Root Short lived)



Ex - Grass Root
- Onion

} Monocot

Structure of Primary Root

(a) **Root cap** → – Thimble Shape, Parenchyma cells

Protect tender(soft) Apex | Meristimatic zone

When Root Enter in soil

Root cap Absent – Aquatic plant Root (Eicchornia), Pistia)

– Aerial Root

(b) Meristimatic Zone – cells Dividing

Dividing cell Feature → Spherical shape

→ more Plasmodesmatal connection)

– large nucleus ✓

– Cytoplasm dense

– cell wall thin

– Vacuole Absent

5.1 The Root

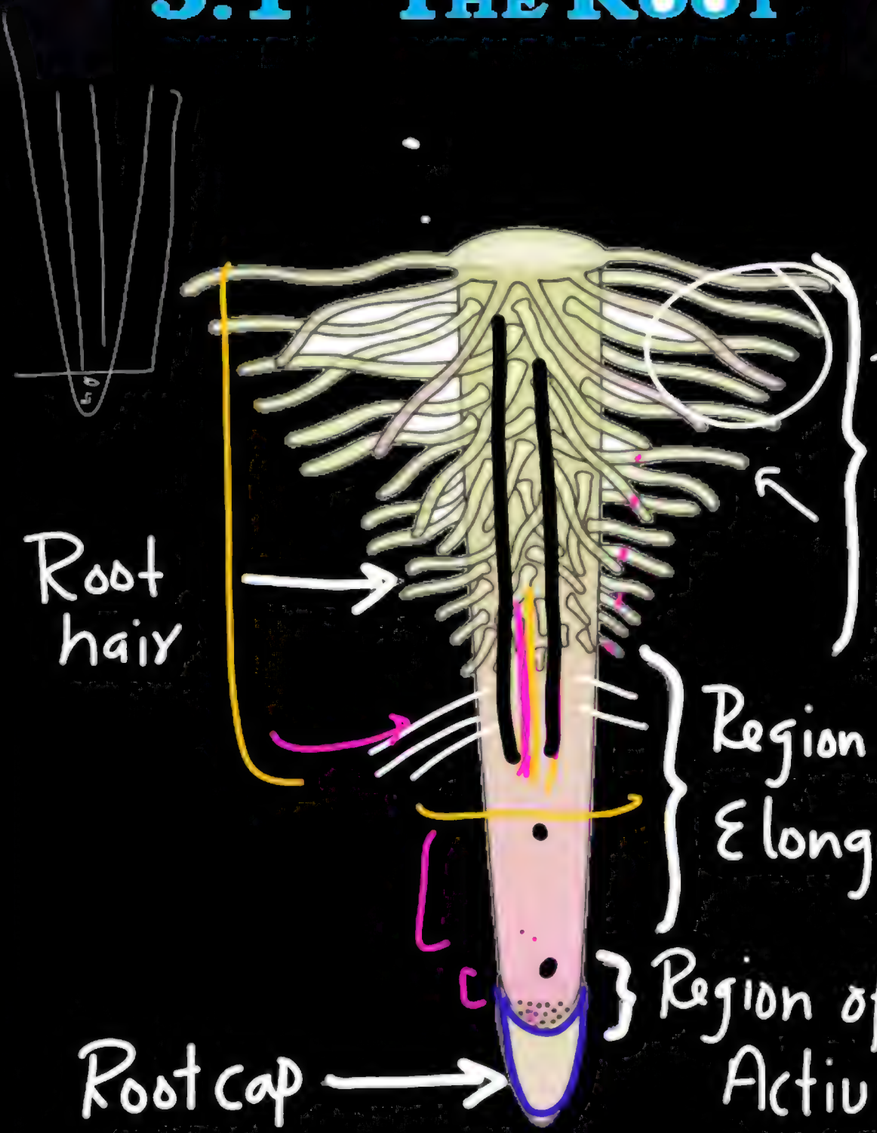
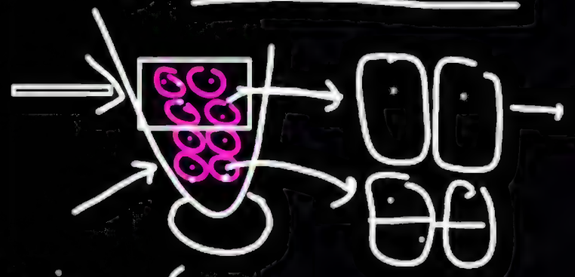


Figure 5.3 The regions of the root-tip

(c) Region of Elongation → Cells length/Size Increase



→ Cells Become Permanent

→ Region Actually Responsible For Growth

(d) Maturation Zone →

- Largest Zone ✓

→ all cells permanent Role is Fixed

→ Some Epidermal cells produce Root hair

→ Size Grow occur For maturation

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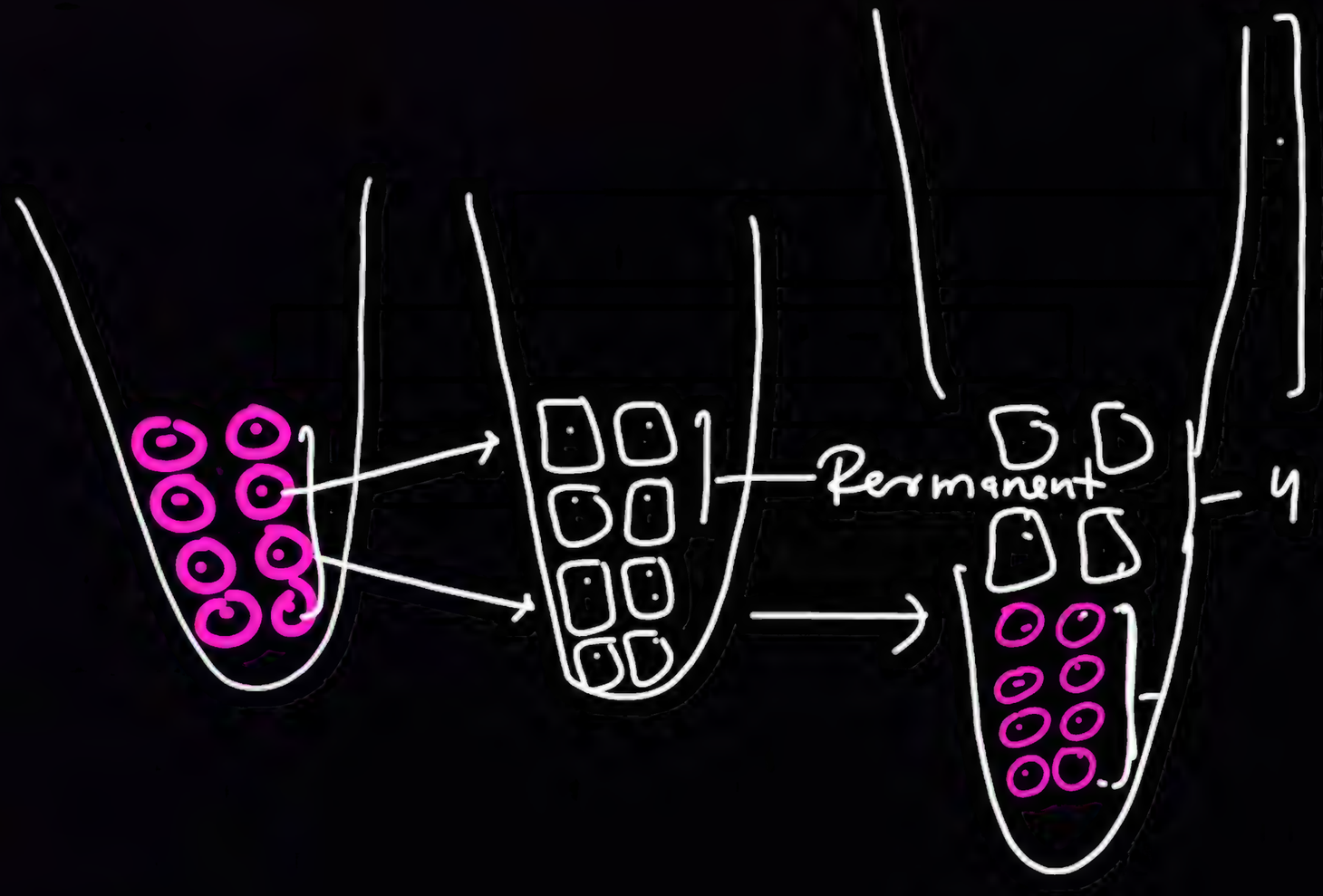

Permanent
4

5.1 The Root

Root modification (other than main Role)

(main Role - Anchorage, Absorb water & Mineral, Hormone synthesis)

I Storage

- Tap Root modify
  - Carrot, Raddish, turnip
- Adventitious Root modify
  - Ex - Sweet potato
  - Asparagus

II

- Banyan — Support
  - Prop Root (Ex - Banyan)
- Stilt Root — Ex - Maize

Respiration

- Pneumatophore
  - Small Pore
- Marshy Area
- Ex - Rhizophora

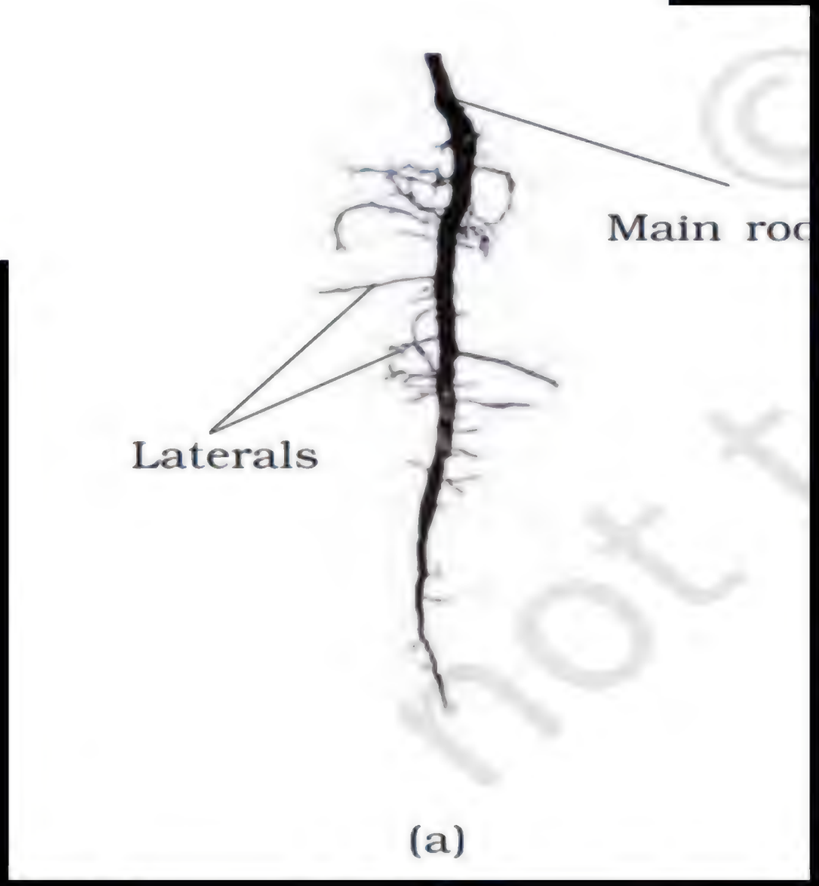
5.1 The Root

In majority of the dicotyledonous plants, the direct elongation of the radicle leads to the formation of **primary root** which grows inside the soil. It bears lateral roots of several orders that are referred to as **secondary, tertiary,** etc. **roots.**

5.1 The Root

tertiary, etc. **roots.** The primary roots and its branches constitute the

tap root system as seen in the mustard plant (Figure 5.2a). In monocotyledonous



5.1 The Root

plant (Figure 5.2a). In monocotyledonous plants, the primary root is short lived and is replaced by a large number of roots. These roots originate from the base of the stem and constitute the **fibrous root system**, as seen in the wheat plant (Figure

Fibrous roots

5.1 The Root

5.2b). In some plants, like grass, *Monstera* and the banyan tree, roots arise from parts of the plant other than the radicle and are called **adventitious roots**

(Figure 5.2c). The main functions of the root system are absorption of water and minerals from the soil, providing a proper anchorage to the plant parts, storing reserve food material and synthesis of plant growth regulators.

5.1 The Root

divide repeatedly. The cells proximal to this region undergo rapid elongation and enlargement and are responsible for the growth of the root in length. This region is called the **region of elongation**. The cells of the elongation zone gradually differentiate and mature. Hence,

region of elongation. The cells of the elongation zone gradually differentiate and mature. Hence, this zone, proximal to region of elongation, is called the **region of maturation**. From this region some of the epidermal cells form very fine and delicate, thread-like structures called **root hairs**. These root hairs absorb water and minerals from the soil.

Stem

Basic Feature

(a) Develop From plumule ✓

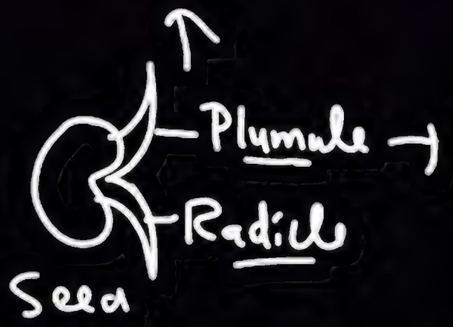
(b) node & internode present

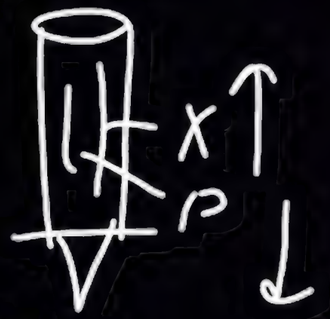
(c) Stem bear – Branch, Leaf & Flower

(d) Stem → Positive phototropic
Negative Geotropic – Grow Away From Gravity

(e) Shoot → Stem or Branch → Leaf present known as Shoot

Role of Stem – (a) Bear leaf, Branch & Flower (b) Transport of Food, Mineral, water
(c) Can produce some Hormone

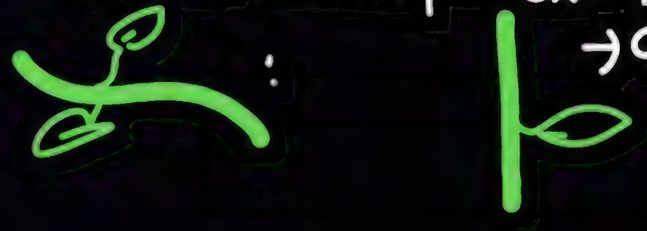




Type of stem

In herb, shrub & tree Different type stem present

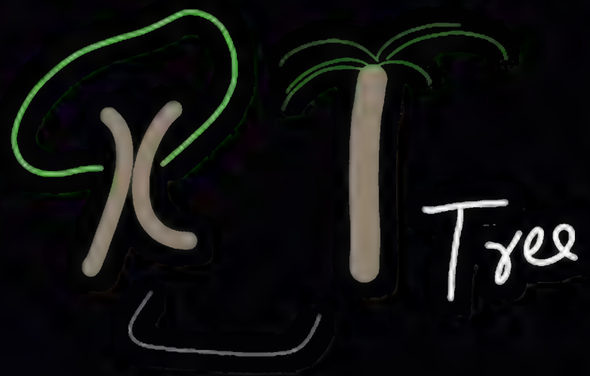
(a) Plant is Herb – Green stem never woody – Ex – tomato → Grass



(b) Shrub – Stem initially Green later Brown

Ex – tulsi ✓
→ Rose ✓
→ Citrus ✓

(c) Tree → Stem woody – thick stem



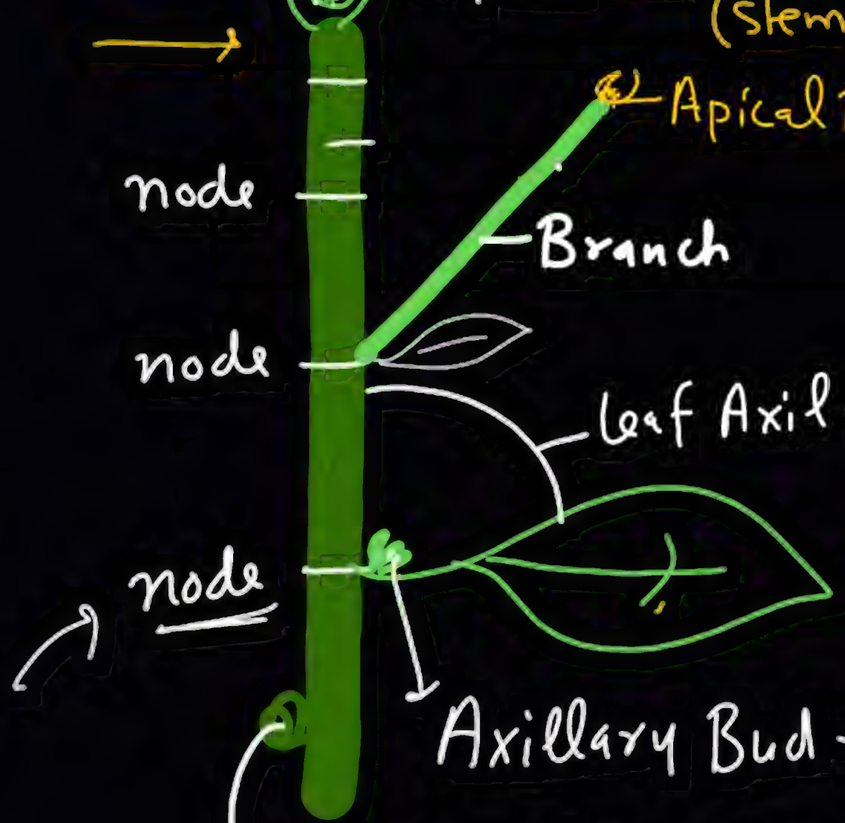
Buds in stem

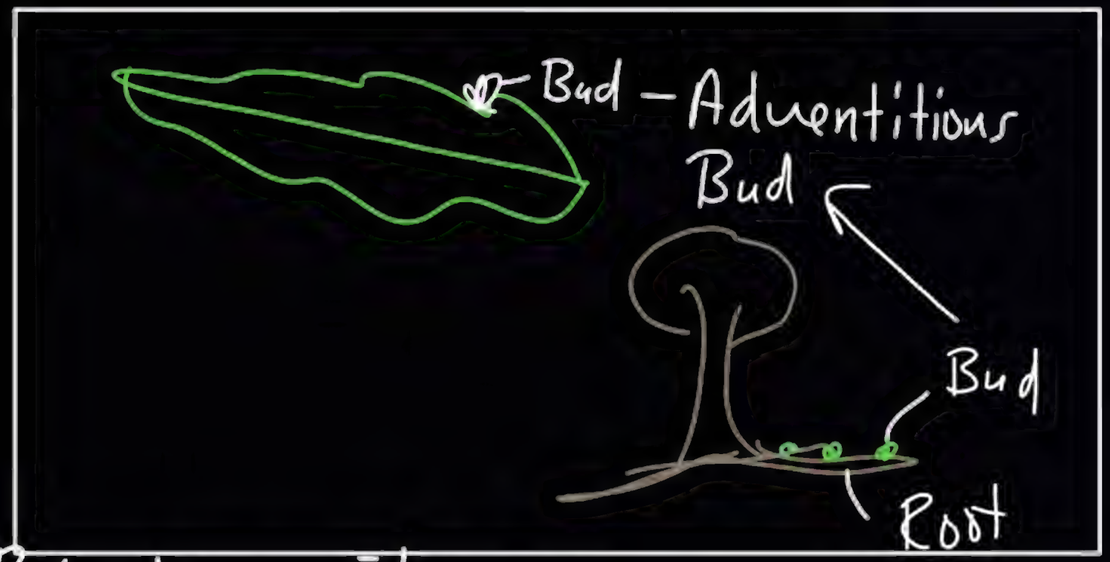
Meristem And Undifferentiated Leaf

For

Apical Bud - Shoot tip → Growth Responsible

(Stem, Branch → Leaf Form





Axillary Bud → Give Branch or Flower

Adventitious Bud - other than Node

On the Basis of Role - Classification

(a) Vegetative Bud → Give Branch & Leaf

(b) Floral Bud → Give Flower

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Morphology of Flowering plant

lecture - 07

Botany

TARUN SIR

Topics

no. of Question – 4Q

1. Inflorescence →
2. Flower →
3. Fruit & Seed
4. Family →

→ 3Q or 4Q

Root]
Stem]
leaf]

Structure + Modification → 1Q

Part delete

Summary

	Brassicaceae	Fabaceae	Solanaceae	Liliaceae	Malvaceae	Asteraceae	Poaceae
Dicot or Monocot	D	D	D	M	D	D	M
Inflorescence	R	R	C	C	C	R	R
Symmetry	A	Z	A	A	A	A – Dic Z – Ray	Z
Isomery →	Tetra	P	P	Tri	P	P	tri
ovary →	H	H	H	H	H	E	H
Aestivation	–	Vexillary	–	–	twisted	–	–
Androecium	Unequal stamen	Diadelphous	Epipetalous	Epiphyllous	Monadelphous	Syngenisious	–
Gynoecium	G(2)	G1	G(2)	G(3)	–	–	–
Placentation	Parietal	Marginal	Axile	Axile	Axile	Basal	Basal

Summary

	Brassicaceae	Fabaceae	Solanaceae	Liliaceae	Malvaceae	Asteraceae	Poaceae

cell theory

leaf

Feature → Flat structure – develop From Apical Bud (on Branch or stem)

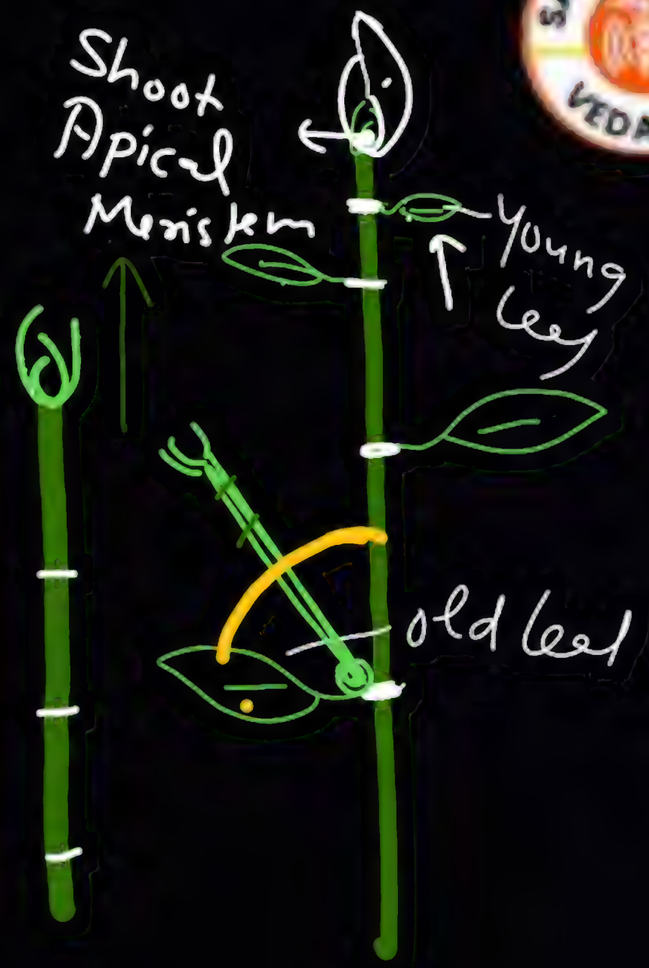
→ leave develop laterally develop

→ Acropetal arrangement of leaf

→ leaf present on node

→ leaf Axil develop Bud → Axillary Bud

Branch tip have Apical Bud ← develop Branch



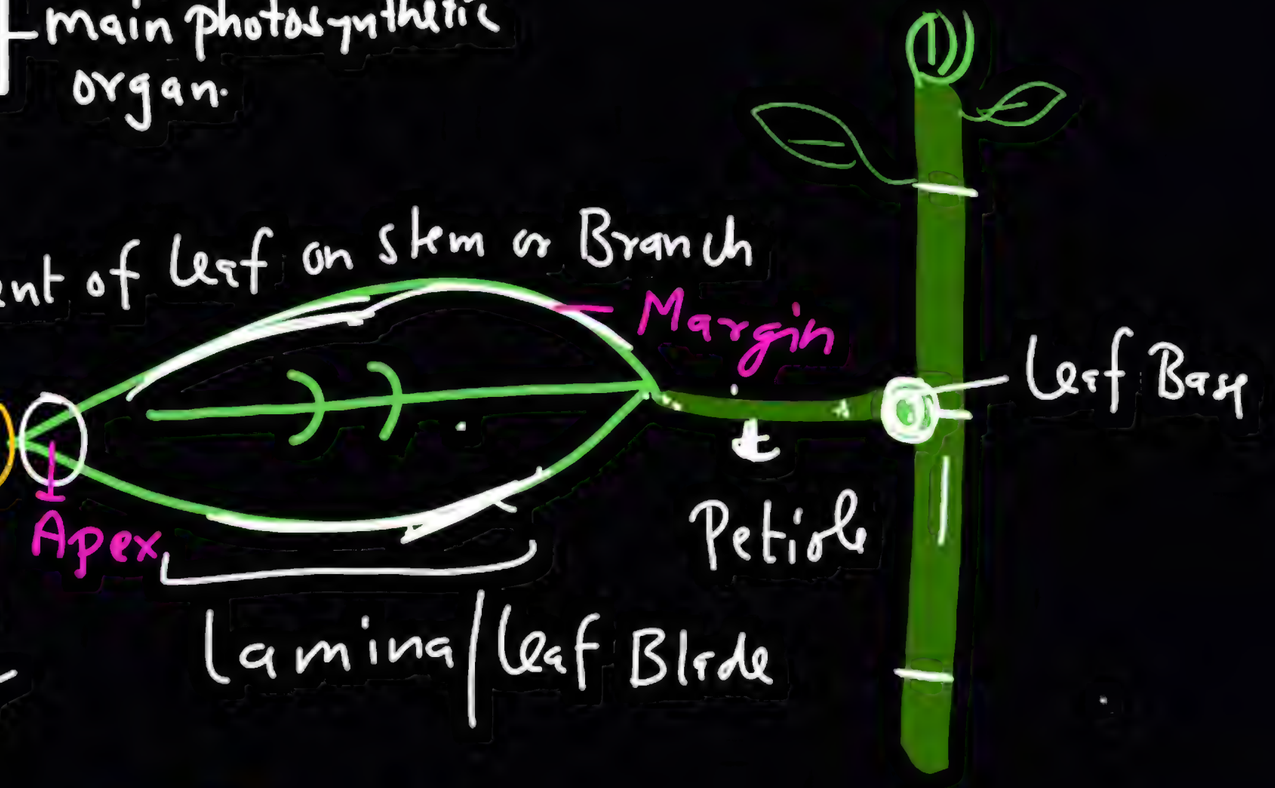
5.3 The Leaf

The leaf is a lateral generally flattened structure borne on the stem. It develops at the node and bears a bud in its axil. The **axillary bud** later develops into a branch. Leaves originate from shoot apical meristems and are arranged in an acropetal order. They are the most important vegetative organs for photosynthesis.

Structure of leaf — main photosynthetic organ

Leaf – three part

(a) Leaf Base – attachment of leaf on stem or Branch



(b) Petiole → It Bring lamina Away From Branch
– It orient lamina For Sunlight

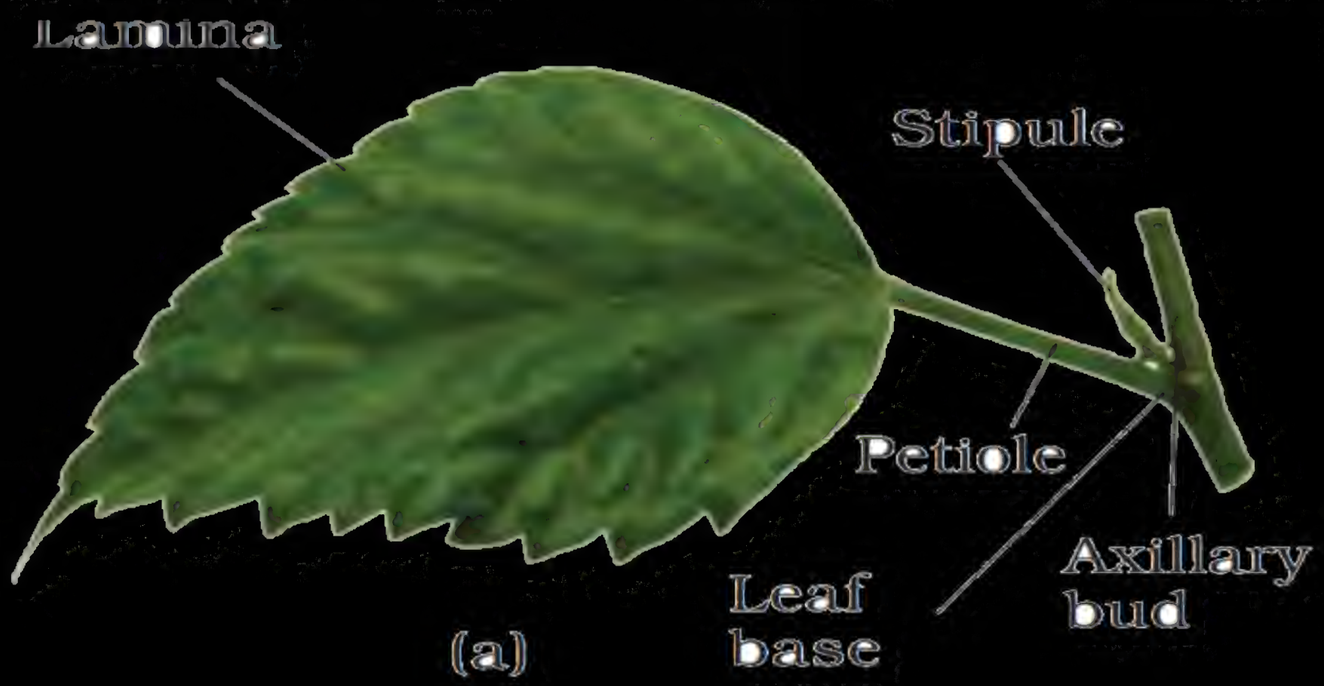
→ Flutter in Air – transpiration occur

(c) lamina → Leaf Blade – Main photosynthetic part of leaf ((largest Surface Area)

lamina have Margin & Apex

5.3 The Leaf

A typical leaf consists of three main parts: leaf base, petiole and lamina (Figure 5.4 a). The leaf is



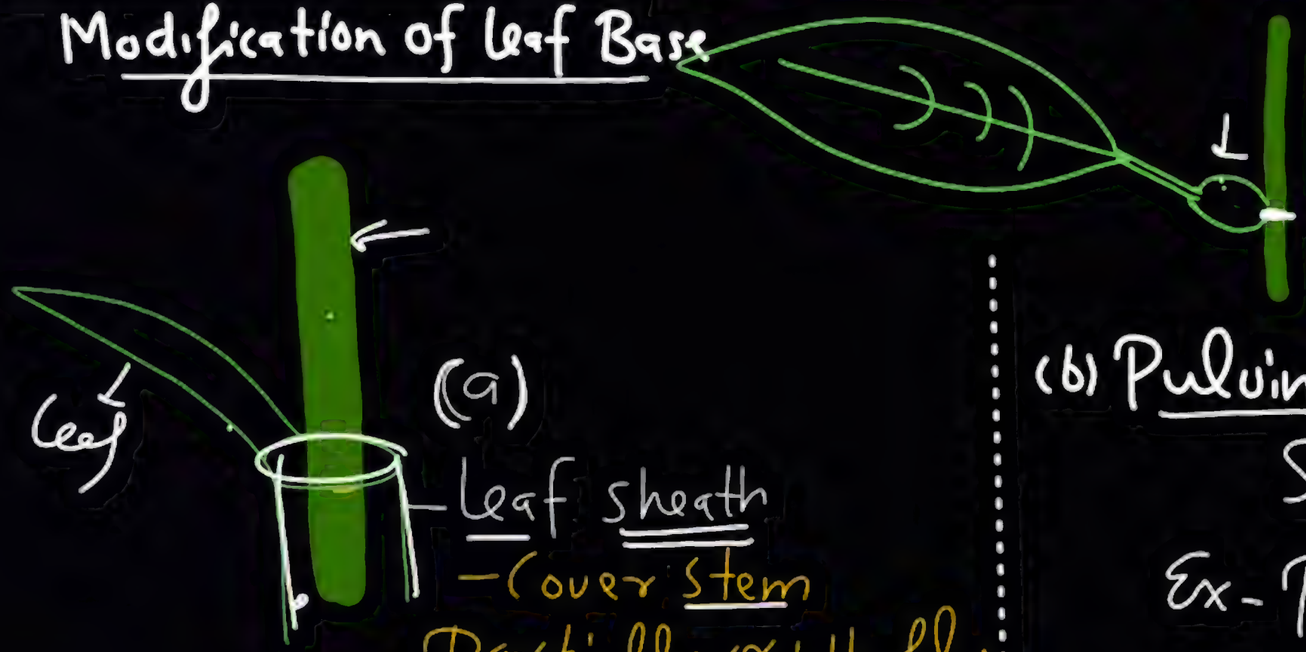
5.3 The Leaf

The leaf is attached to the stem by the **leaf base** and may bear two lateral small leaf like structures called stipules. In monocotyledons, the leaf base expands into a sheath covering the stem partially or wholly. In some leguminous plants the leafbase may become swollen, which is called the **pulvinus**. The **petiole**

leaf Base

– It is Attachment of leaf to stem

Modification of leaf Base



(a)

– Leaf sheath

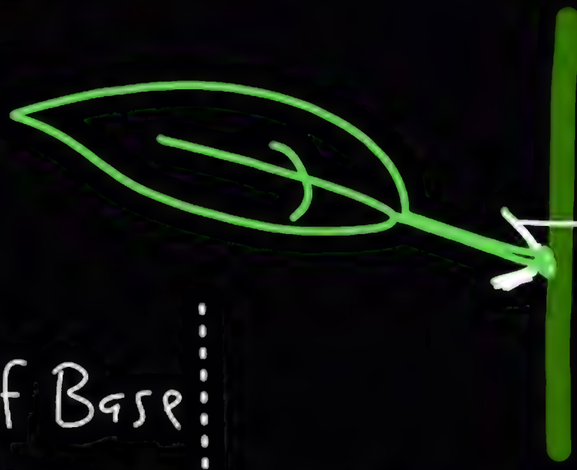
– Cover Stem

Partially or Wholly

Ex – Wheat, Maize

(b) Pulvinus – Leaf Base Swollen

Ex – Pea



(c)

Stipule

↓

Small Structure

develop From leaf Base on Both side

Ex – Bean

Venation in leaf

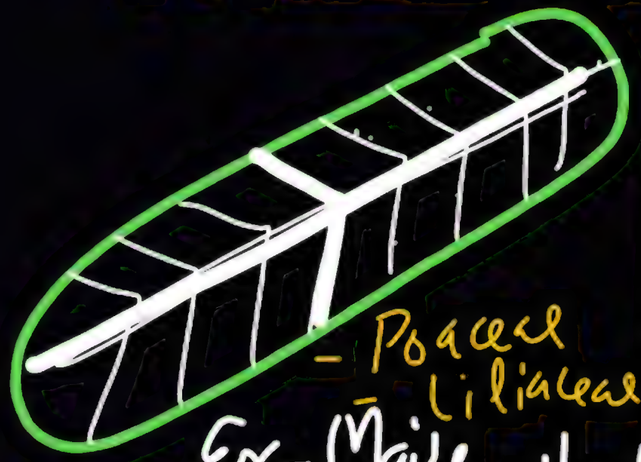
Lamina →

- On lamina Veins present - which Keep leaf in Expose Form (Photosynthesis can occur)
- largest vein → in middle of leaf - Mid rib

Venation → It is Arrangement of vein on lamina

Two type of venation

(a) Parallel venation - present in monocot



- Poaceae
- Liliaceae

Ex- Maize, wheat, Sugarcane

Veins parallel

(b) Reticulate venation →

Veins Form network Form on lamina

Ex- Dicot

Ex- Mustard, Pea tomato, Peepal, China rose

Type of leaf

→ Two type of leaf – (a) Simple leaf (b) Compound leaf

(A) Simple leaf → Margin of lamina Smooth (Entire) or incision (Cut) present

not Reach upto mid rib

Ex – Pea
→ Banyan
– Mango
– China rose

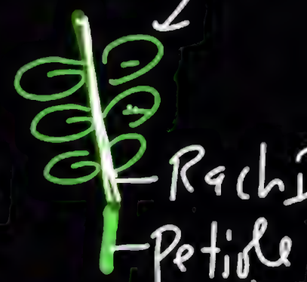
② Compound leaf – incision in lamina Reach upto Mid rib

now known as → Rachis

Compound leaf

Two type of Compound leaf →

① Pinnate compound
- Rachis present on top of petiole
→ Leaflet attach on Rachis

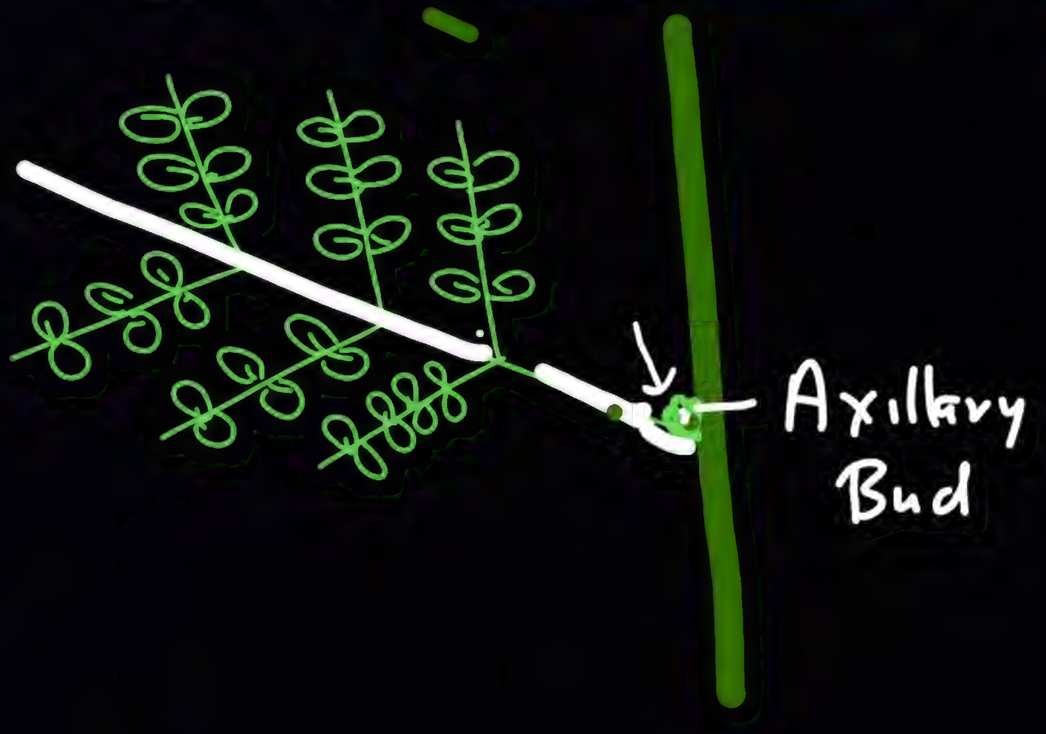


Ex - Neem

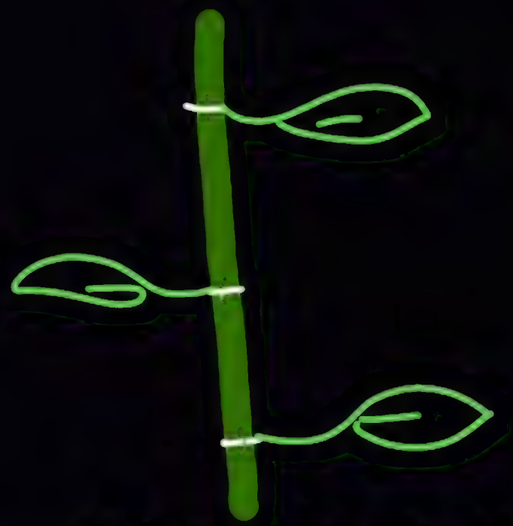
② Palmately Compound
- Leaflet Attach on petiole

Ex - Silk cotton

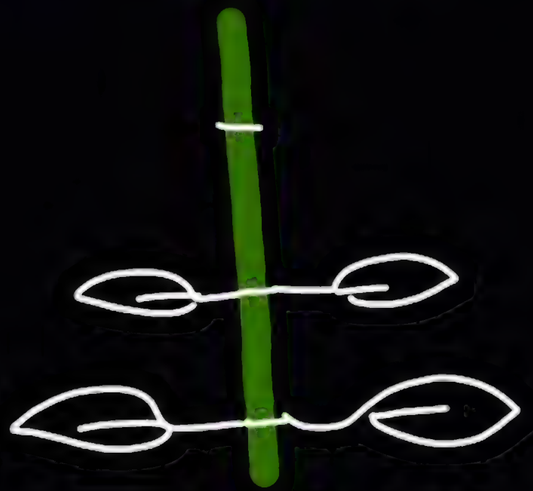
note- Axillary Bud is present in Axil of leaf not leaflet



Phyllotaxy - It is Arrangement of leaf on Branch or stem



Alternate Phyllotaxy
(most common)
Mustard
China rose
Sunflower



Opposite
- 1 node = 2 leaf
Ex - Guava
- Calotropis

Whorled phyllotaxy
- one node, more than two leaf
Ex - Alstonia

Families

NCERT

New Family

Poaceae ⟶ Perianth, B

Asteraceae → Ray Floret, EP

Malvaceae → A

Solanaceae

5.9.2 Solanaceae

It is a large family, commonly called as the 'potato family'. It is widely distributed in tropics, subtropics and even temperate zones (Figure 5.22).

Vegetative Characters

Plants mostly herbs, shrubs and rarely small trees

Stem: herbaceous, rarely woody, aerial, erect, cylindrical, branched, solid or hollow, hairy or glabrous, underground stem in potato (*Solanum tuberosum*)

Leaves: alternate, simple, rarely pinnately compound, exstipulate; venation reticulate

Solanaceae

Floral Characters

Inflorescence : Solitary, axillary or cymose as in *Solanum*

Flower: bisexual, actinomorphic

Calyx: sepals five, united, persistent, valvate aestivation

Corolla: petals five, united; valvate aestivation

Androecium: stamens five epipetalous

$\oplus \; ♂ \; K_{(5)} \overbrace{C_{(5)} \; A_5}$

Gynoecium: bicarpellary obligately placed, syncarpous; ovary superior, bilocular, placenta swollen with many ovules, axile

$\underline{G_{(2)}}$

Fruits: berry or capsule

Seeds: many endospermous

Floral Formula: $\oplus \; ♂ \; K_{(5)} \; \overbrace{C_{(5)} \; A_5} \; \underline{G_{(2)}}$

Economic Importance

Many plants belonging to this family are source of food (tomato, brinjal, potato), spice (chilli); medicine (belladonna, *ashwagandha*); fumigatory (tobacco); ornamentals (petunia).

Poaceae
Liliaceae } Perianth – P

⊕ ⊕ ⊕

Brassicaceae → $K_{2+2}C_4$

Fabaceae → $K_{(5)}\ C_{1+2+(2)}\ A_{(9)+1}$

Vexillary

Solanaceae → ⊕ ♀ $K_{(5)}\ C_{(5)}\ A_5$

- Asteraceae
- Malvaceae

(a) Brassicaceae → K_{2+2}

(b) Fabaceae – Vexillary – $C_{1+2+(2)}$

(c) Solanaceae – Epipetalous

(d) Liliaceae – Actinomorphic

Epiphyllous

⊕ ♀ $P_{(3+3)}\ A_{3+3}$

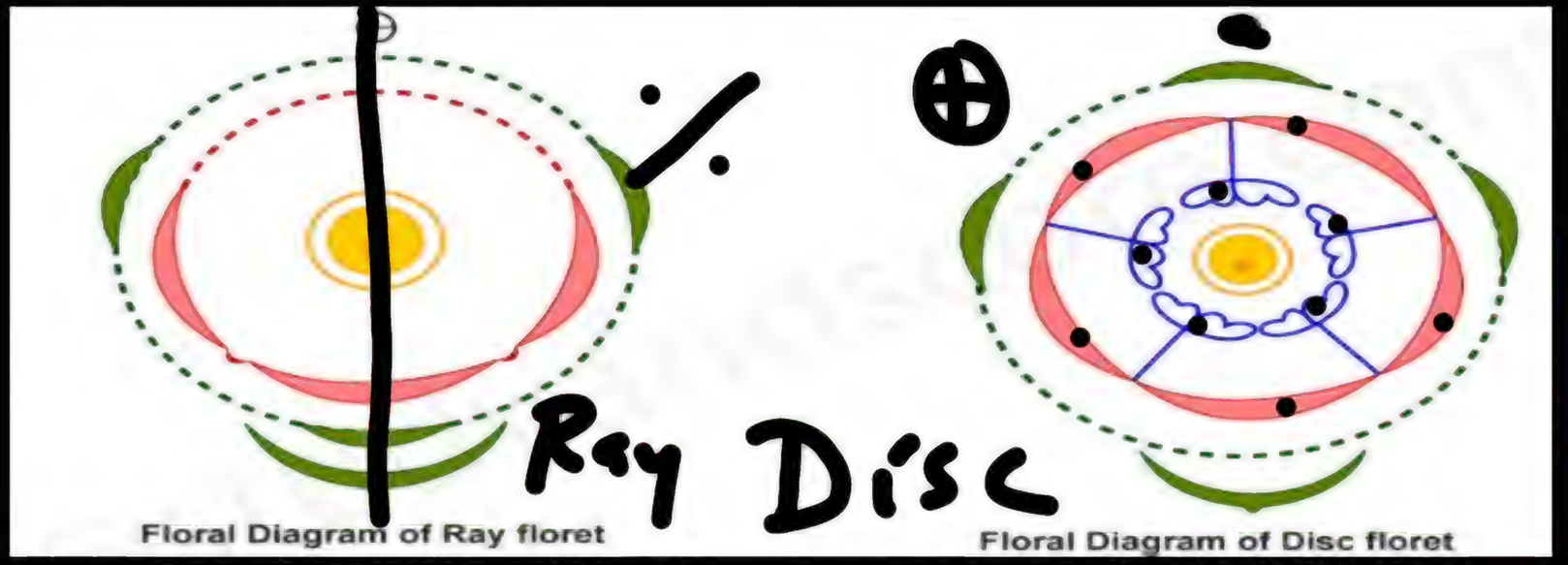
(e) Poaceae – Perianth, Zygomorph

(f) Asteraceae – two Formula

(g) Malvaceae →

⊕ Pentamerous $A_{(\infty)}$

Thank you


Ray Disc
Floral Diagram of Ray floret
Floral Diagram of Disc floret

Mother Axis

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Photosynthesis in higher plants

lecture - 01

Botany

TARUN SIR

Topics

(Summary – Smart one shot)

1 [Experiments]

2 [
- location of Photosynthesis
- type of pigments
- Light Reaction
- Chemiosmotic hypothesis
]

2 [Dark Reaction
photorespiration]

C-4 plants

1 [Factors Affecting Photosynthesis]

[150 ① → FEG]

3-4 ① (conceptual Question)

Introduction

In this chapter - higher plants

- Autotrophic nutrition → CO_2 (Inorganic) → Reduction → Glucose ($C_6H_{12}O_6$) (organic)

- Autotrophic nutrition → Reduction of CO_2 occur, For this two Requirement

(a) Energy (Sunlight → Photo autotroph → Pigment present
Chemical Rxn → Chemo autotroph → Pigment Absent

(b) Hydrogen

- Photoautotroph (Use Sunlight Pigment)

$$CO_2 + H_2O \longrightarrow \text{Glucose} + O_2 \text{ (By product)}$$

(H_2O Source of Hydrogen; O_2 Oxygenic)

$$CO_2 + H_2S \longrightarrow \text{Glucose} + S$$

(H_2S Source of Hydrogen; S Oxygen not from; Anoxygenic)

Plant Kingdom → Algae, Bryophytes, Pteridophytes, Gymnosperm, Angiosperm

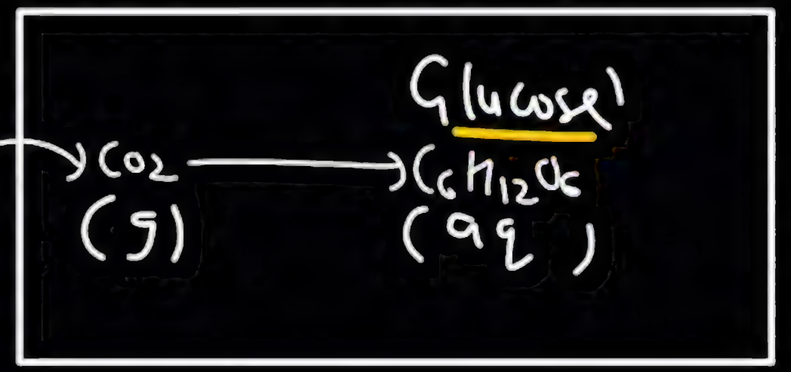
Higher plants

Entire plant Kingdom – Oxygenic photosynthesis

→ In this chapter – Oxygenic Photosynthesis – Study

- (H_2O – donor of Hydrogen)
- Oxygen produce
- Chlorophyll is Pigment

Important points — Photosynthesis



(a) Cellular process – Occur inside Cell

(b) Reduction of CO_2 occur

(c) Inorganic Convert into Organic
(CO_2) (Glucose)

(d) Endothermic (Energy Require) — From Sunlight

(e) Energy Trap By Pigments From Sunlight

(f) Enzymatic process → So it is Metabolic process → Anabolic (Synthesis occur)

(h) It is Physico Chemical process

(e) Oxygen Form → Oxygenic

Photosynthesis have two important Role

(a) O_2 produce → use in Respiration to produce Energy

(b) Food For all Heterotroph (Organic)

Q Not true About photosynthesis

(a) Anabolic (b) Physico chemical (c) Reduction (d) Extra cellular process

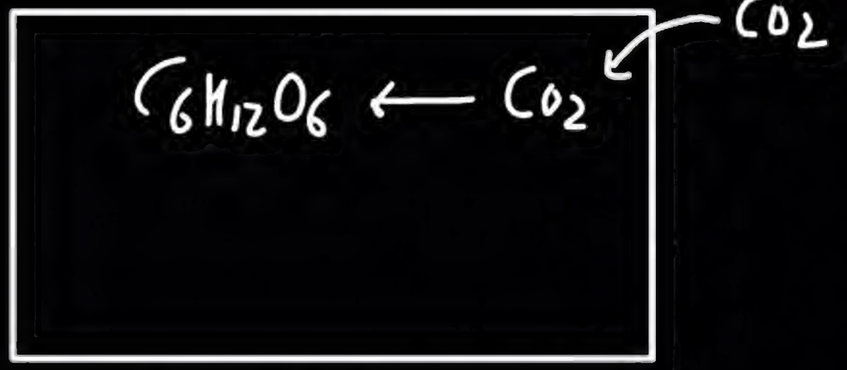
All animals including human beings depend on plants for their food. Have you ever wondered from where plants get their food? Green plants, in fact, have to make or rather synthesise the food they need and all other organisms depend on them for their needs. The green plants make or rather synthesise the food they need through photosynthesis and are therefore called autotrophs.

Process

Organism

You have already learnt that the autotrophic nutrition is found only in plants and all other organisms that depend on the green plants for food are heterotrophs. Green plants carry out 'photosynthesis', a physico-chemical process by which they use light energy to drive the synthesis of organic compounds. Ultimately, all living forms on earth depend on sunlight for

Cyanobacteria



compounds. Ultimately, all living forms on earth depend on sunlight for energy. The use of energy from sunlight by plants doing photosynthesis is the basis of life on earth. Photosynthesis is important due to two reasons: it is the primary source of all food on earth. It is also responsible for the release of oxygen into the atmosphere by green plants. *Have you ever thought what*

Experiments Related to photosynthesis

- Photosynthesis – process ⟶ Requirements ⟶ ① Energy ② Pigment ③ CO_2 ④ H_2O

Production of Glucose

CO_2 ↓ Reduction ($C_6H_{12}O_6$)

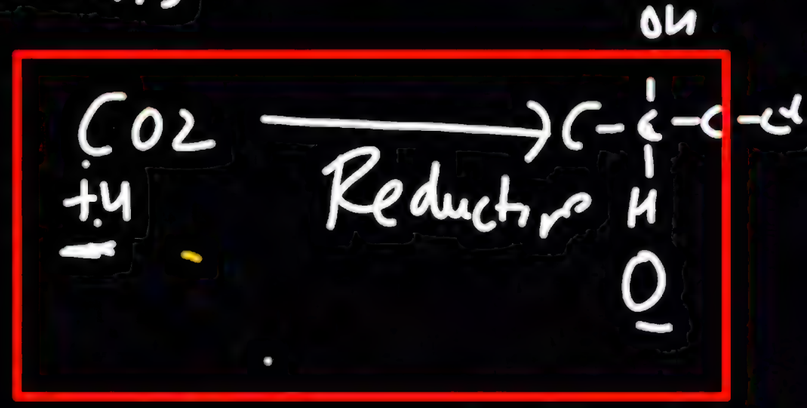
⇒ It is not Discovered in Single Day

⇒ Experiments Related to photosynthesis – Started as Early as 18th Centure

Evidence of Photosynthesis in Experiments

(a) Starch appear (test By Iodine) Blue Black

(b) Oxygen



List of Experiments

1 (a) Variegated Leaf]
2 (b) KOH - half leaf] Result - Green Area - Photosynthesis occur in presence of light

CO_2 is Important for Photosynthesis

3 (c) Bell Jar (Priestley) (1770) Experiment
Mice & Candle - Damage Air Quality
Mint plant - Restore Air Quality (O_2 produce)

4 (d) Ingenhousz
→ Light is Important
→ High light intensity can produce O_2 Bubble

5 (e) Von Sach

(f) T.W Engleman

6

(g) Van neil

7

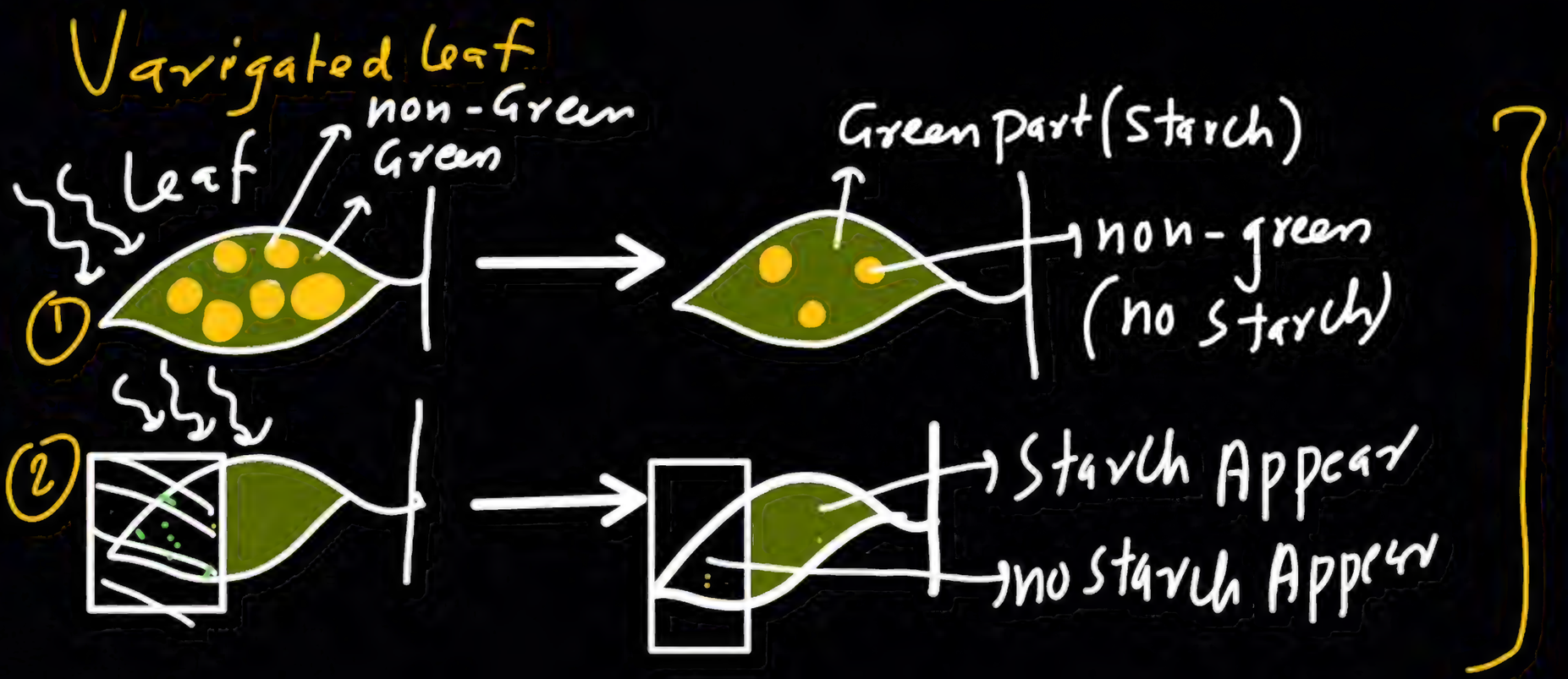
Let us try to find out what we already know about photosynthesis. Some simple experiments you may have done in the earlier classes have shown that chlorophyll (green pigment of the leaf), light and CO_2 are required for photosynthesis to occur.

Class 10th

Experiment -01

→ Varigated leaf (Green & non green Area) ⟶ Photosynthesis occur in Green Area ⟶ Starch test in Green Area (Positive)

→ Leaf half cover with Black paper ⟶ Area Expose to Sunlight – Starch Appear



Experiment -01

You may have carried out the experiment to look for starch formation in two leaves - a variegated leaf or a leaf that was partially covered with black paper, and exposed to light. On testing these leaves for the presence of starch it was clear that photosynthesis occurred only in the green parts of the leaves in the presence of light.

Iodine

Experiment – 02 – KOH Experiment

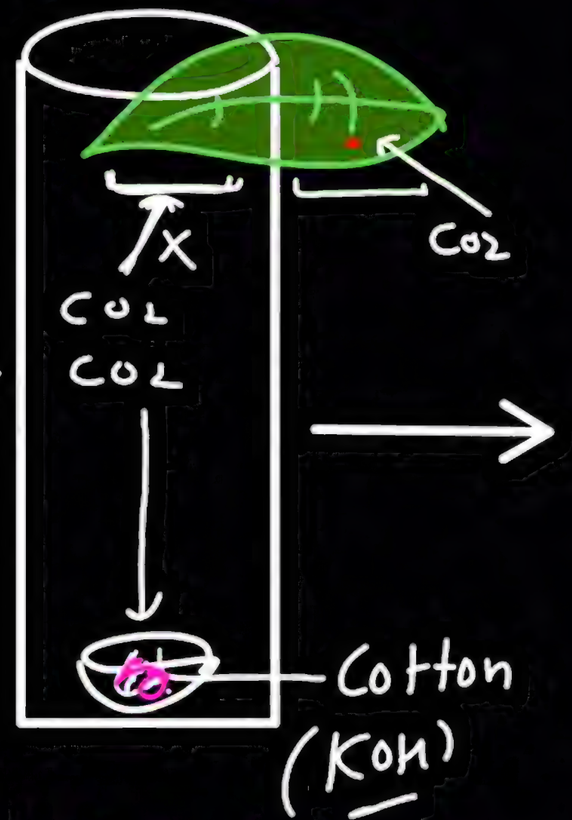
(Half leaf Experiment)

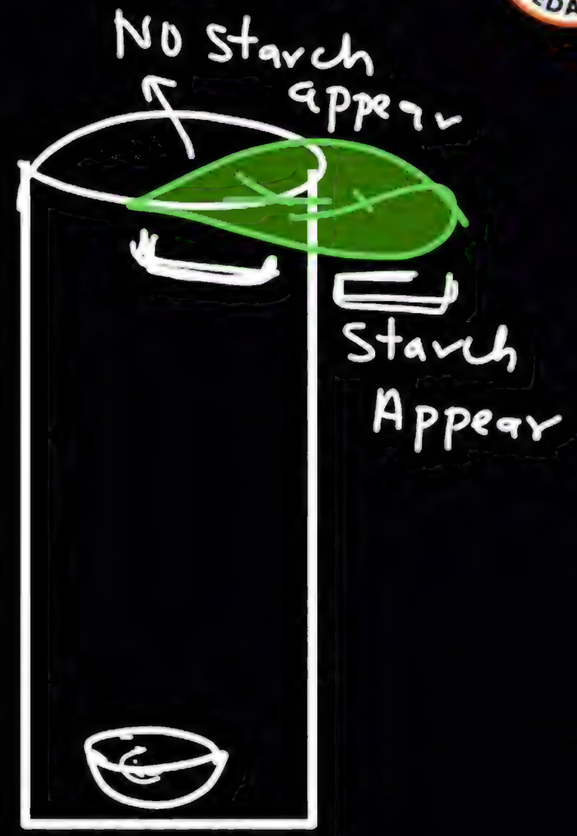
→ Leaf half part → placed in test tube

→ Cotton Soaked with KOH (Absorb CO_2)

→ Leaf part – Outside (CO_2) – Photosynthesis occurs ↓ Starch Appear

→ Plant part → inside test tube → No CO_2





Result → CO_2 is important for photosynthesis

Experiment -02

Another experiment you may have carried out where a part of a leaf is enclosed in a test tube containing some KOH soaked cotton (which absorbs CO_2), while the other half is exposed to air. The setup is then placed in light for some time. On testing for the presence of starch later in the two parts of the leaf, you must have found that the exposed part of the leaf tested positive for starch while the portion that was in the tube, tested negative. This showed that CO_2 was required for photosynthesis. *Can you explain how this conclusion could be drawn?*

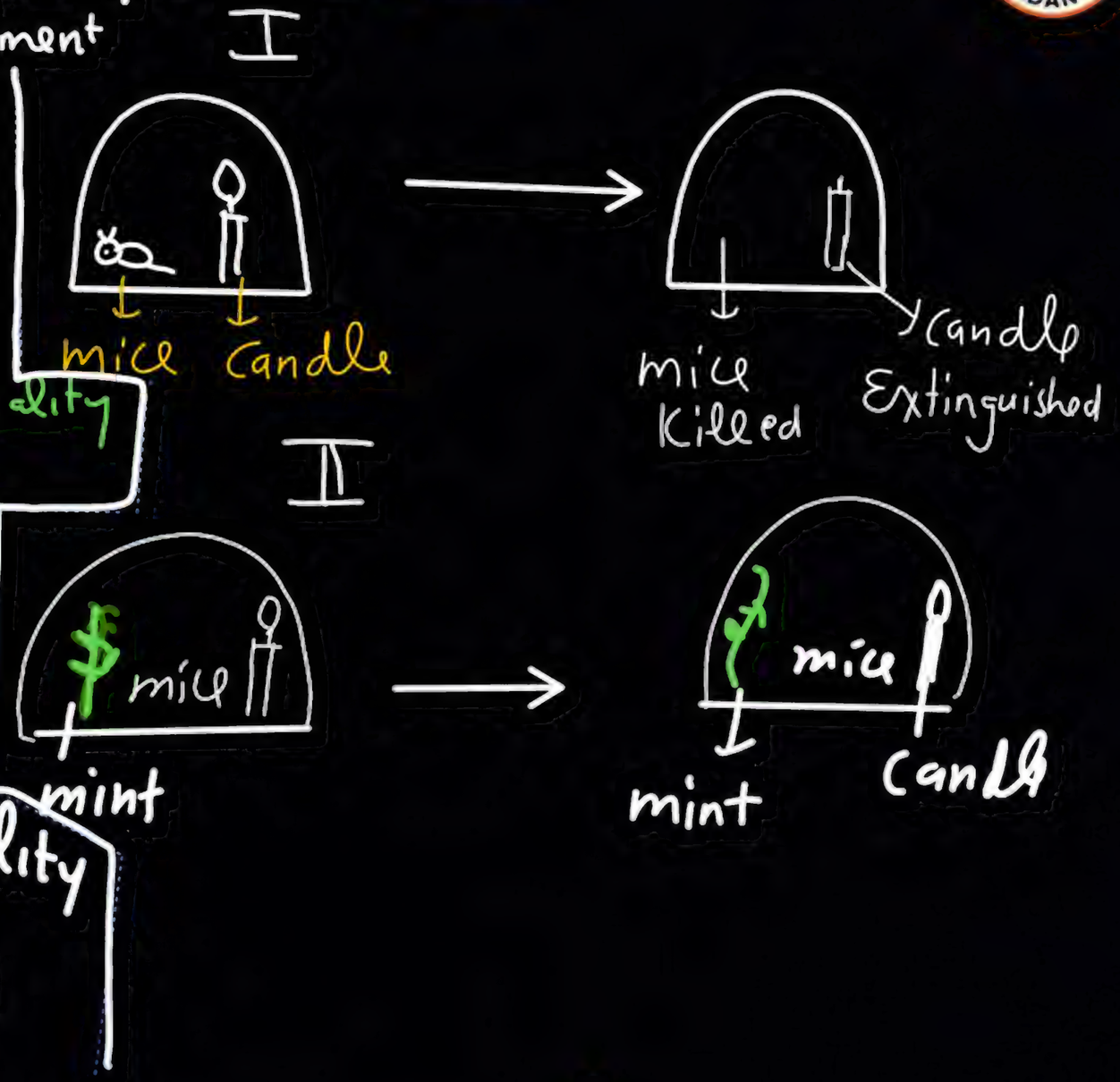
Priestley Experiment – Bell Jar Experiment → 1770

Joseph priestley → Perform Series of Experiment
(O2 Discover)

Setup-I → Candle & Mice → Bell shape Jar
Mice suffocate, & candle Extinguish
Result – Mice and candle damage Air Quality

Set-up-II → Mint plant (Due to) → Mice Alive
Candle Burning

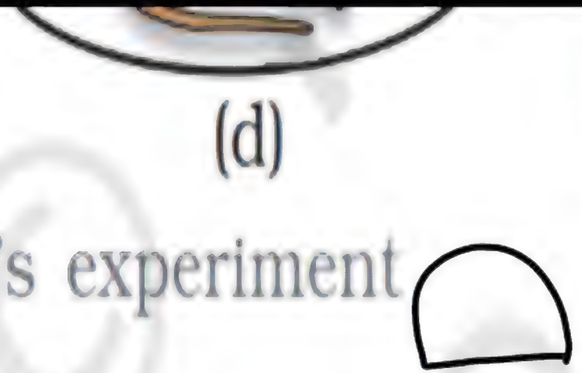
Result – Mint can Restore Air Quality
Damage By Mice & Candle
(Breathing) (Burning)



Priestley Experiment

Joseph Priestley (1733-1804) in 1770 performed a series of experiments that revealed the essential role of air in the growth of green plants. Priestley, you may recall, discovered oxygen in 1774. Priestley observed that a candle burning in a closed space – a bell jar, soon gets extinguished

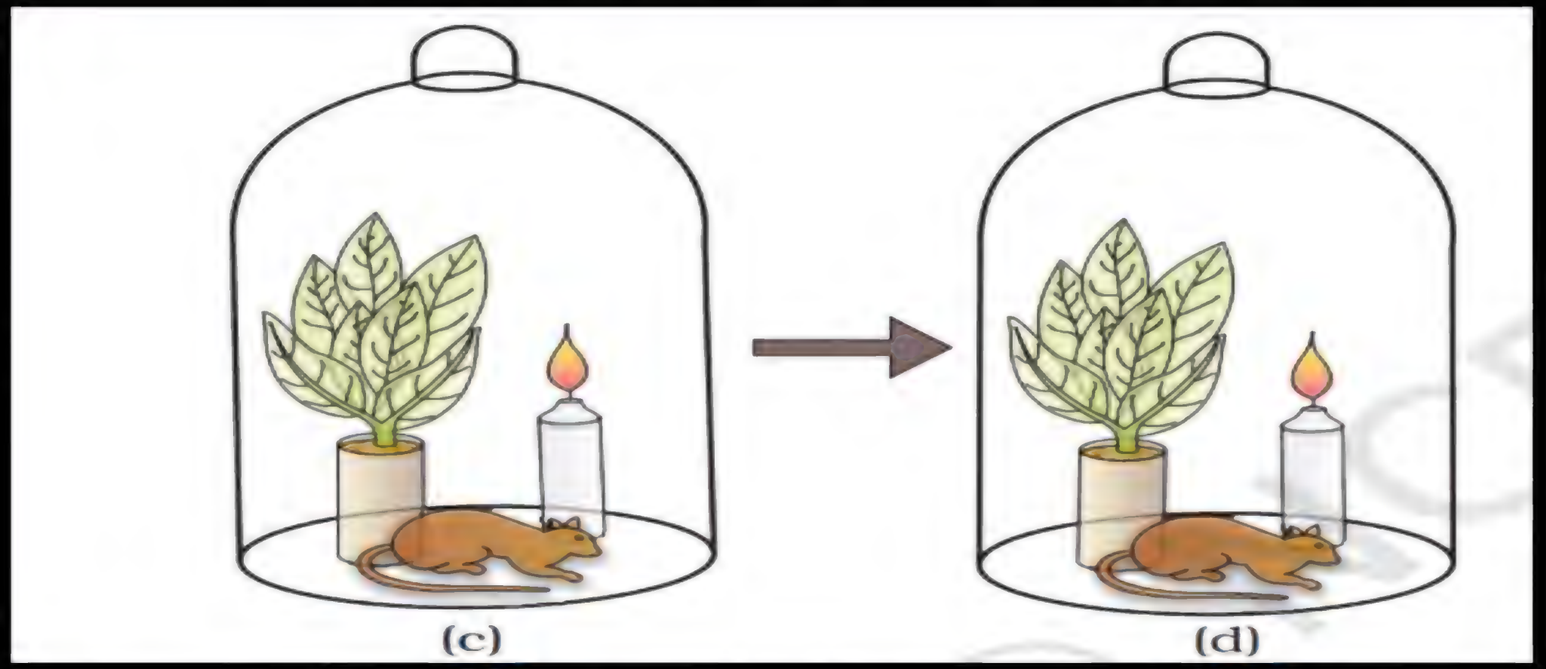
Priestley Experiment



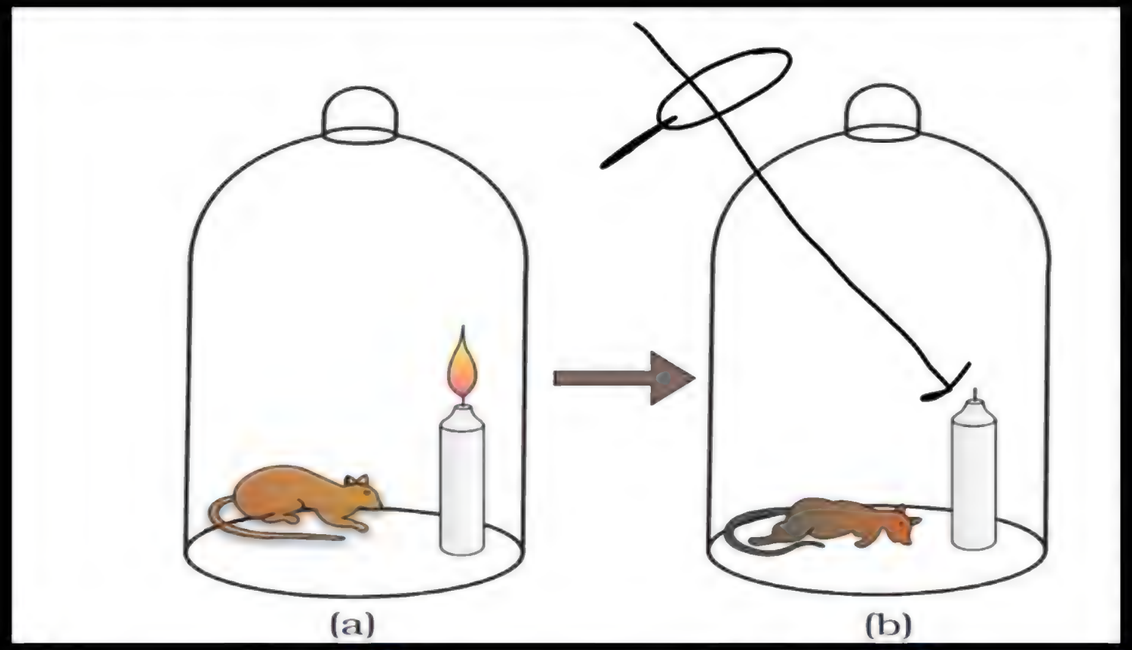
(d)

stley's experiment

(Figure 11.1 a, b, c, d). Similarly, a mouse would soon suffocate in a closed space. He concluded that a burning candle or an animal that breathe the air, both somehow, damage the air. But when he placed a mint plant in the same bell jar, he found that the mouse stayed alive and the candle continued to burn. Priestley hypothesised as follows: Plants restore to the air whatever breathing animals and burning candles remove.


(c)
(d)

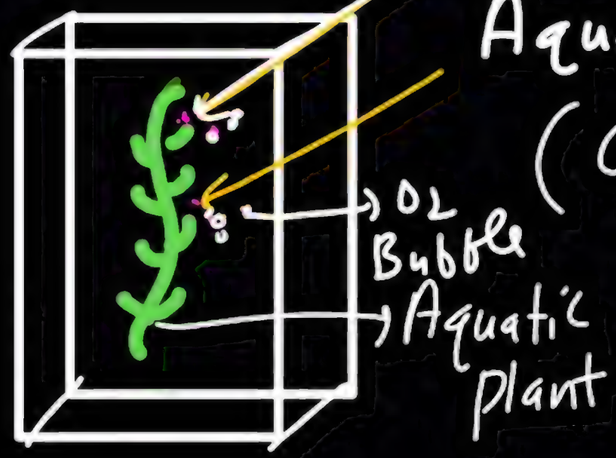
Can you imagine how Priestley would have conducted the experiment using a candle and a plant? Remember, he would need to rekindle the candle to test whether it burns after a few days. *How many different ways can you think of to light the candle without disturbing the set-up?*



Ingenhousz

- Repeat Experiment of Priestley → once in a day & then in Dark
  Result → Mint plant can Restore Air Quality only in Light
  ((light Important))

-

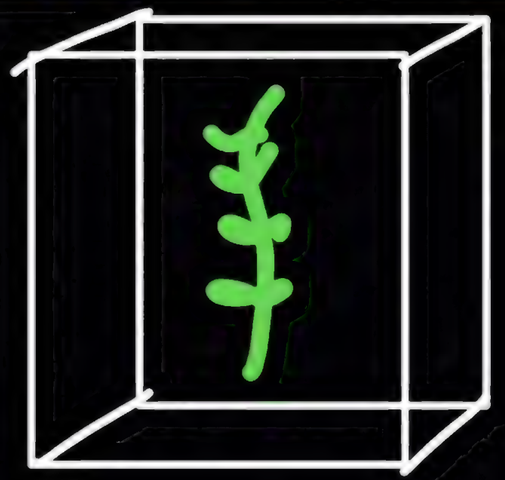


Aquatic plant → light intensity → oxygen Bubble Form
(Green plant can produce oxygen in Bright Light / High light intensity))

Ingenhousz

Using a similar setup as the one used by Priestley, but by placing it once in the dark and once in the sunlight Jan Ingenhousz (1730-1799) showed that sunlight is essential to the plant process that somehow purifies the air fouled by burning candles or breathing animals.

Ingenhousz in an elegant experiment with an aquatic plant showed that in bright sunlight, small bubbles were formed around the green parts while in the dark they did not. Later he identified these bubbles to be of oxygen. Hence he showed that it is only the green part of the plants that could release oxygen.



Q Oxygen gas Discovered - Priestley ✓

Q Oxygen produced By Green Plant → Ingenhousz

MANTHAN NEET 2025 - 1.0 & 2.0

SANKALP NEET VEDANTU

Photosynthesis in higher plants

lecture - 02

Botany

TARUN SIR

Topics

(Summary – Smart one Shot)

1 [Experiments]

2 [
- location of Photosynthesis
- type of pigments
- Light Reaction
- Chemiosmotic hypothesis
]

2 [Dark Reaction
photorespiration]

C-4 plants

1 [Factors Affecting Photosynthesis]

[ISO → FEG]

3-4 Q (conceptual Question)

List of Experiments

1 (a) Variegated Leaf
2 (b) KOH - half leaf
→ Result - Green Area - Photosynthesis occur in presence of light
→ CO_2 is Important For Photosynthesis

3 (c) Bell Jar (Priestley) (1770) Experiment
→ Mice & candle - Damage Air Quality
→ Mint plant - Restore Air Quality (O_2 produce)

4 (d) Ingenhousz
→ Light is Important
→ High light intensity can produce O_2 Bubble

5 (e) Von Sach (1854)
→ Plant Grow → In Green Area - Glucose Form Store in Form of Starch

6 (f) T.W Engleman
→ Light split → Spectral component → Blue & Red wavelength - More photosynthesis
→ First Action spectrum Form → Similar to Absorption spectrum of Chl a & Chl b

7 (g) Van neil
→ O_2 produce in photosynthesis come From H_2O
→ H_2S is Donor of Hydrogen
→ Equation Corrected For photosynthesis ($6CO_2 + 12H_2O \rightarrow C_6H_{12}O_6 + 6O_2$)
→ Verified By - Radio isotope technique

Von Sach – 1854

- Plant Grow ⟶ Glucose Appear ⟶ Store in Form of starch

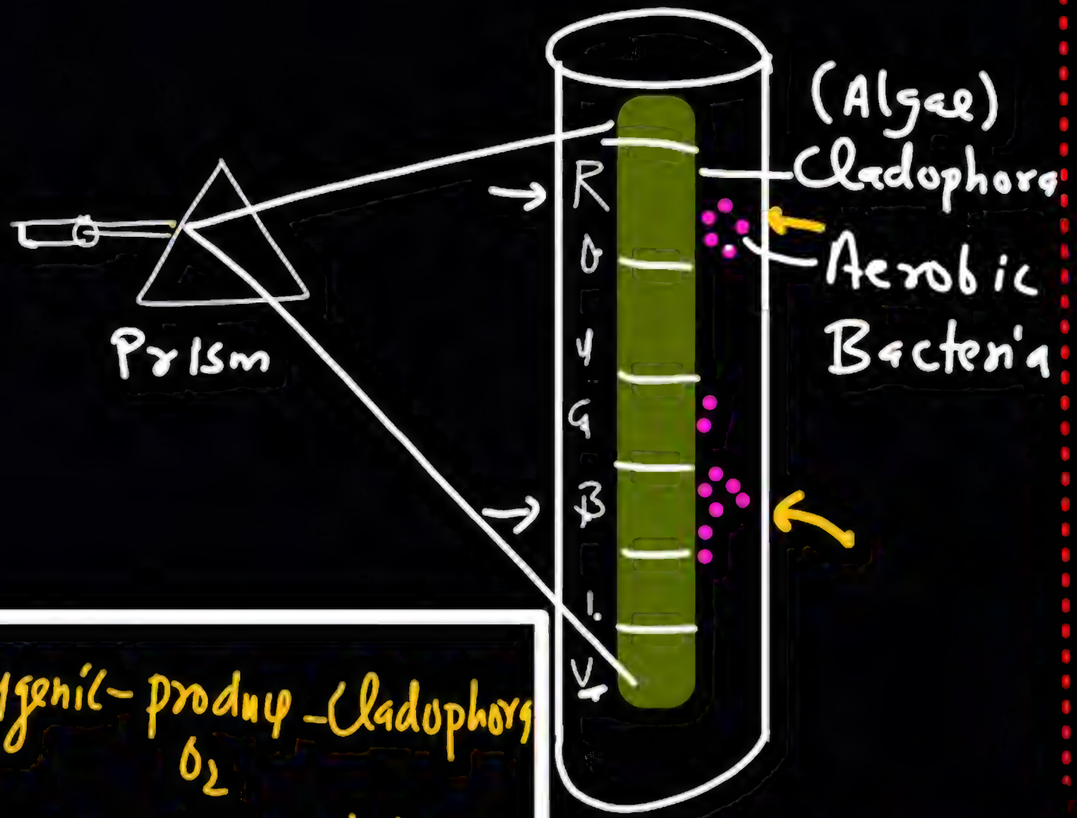
→ later studies → Plant Green chemical present ⟶ Store in Green structure
(Chlorophyll) (Chloroplast)

Result - In Green Part → Glucose Form When plant Grow

Von Sach

It was not until about 1854 that Julius von Sachs provided evidence for production of glucose when plants grow. Glucose is usually stored as starch. His later studies showed that the green substance in plants (chlorophyll as we know it now) is located in special bodies (later called chloroplasts) within plant cells. He found that the green parts in plants is where glucose is made, and that the glucose is usually stored as starch.

T. W Engelmann



Oxygenic - produce - Cladophora
O_2
Aerobic - Attract towards
O_2

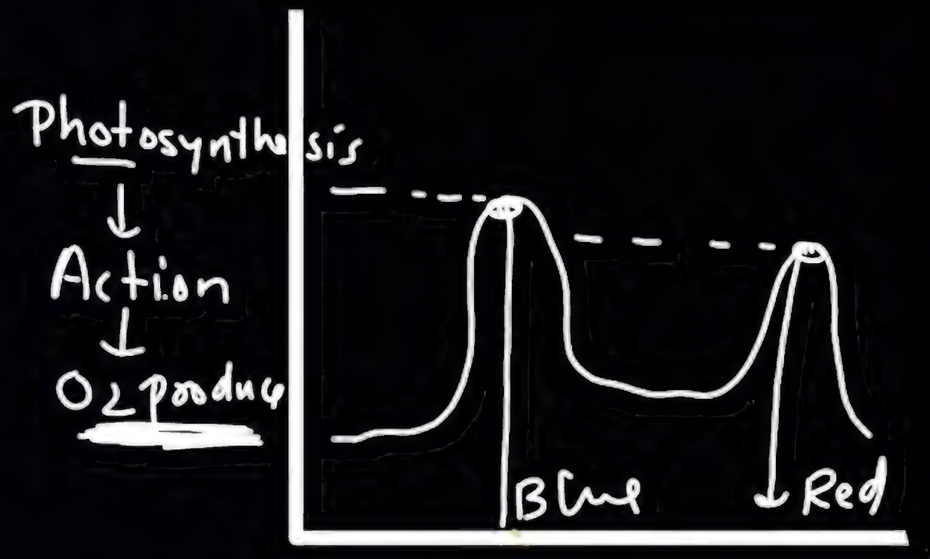
→ Use prism → Break light into spectral Component (Different wavelength)

→ This light Fall on Filamentous Algae → Photosynthesis perform & Produce Oxygen

→ Suspension of Aerobic bacteria present → Attract Red & Blue Region

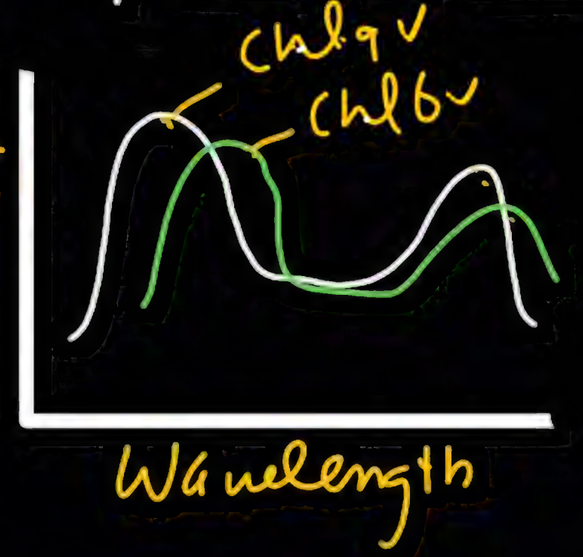
Result - Blue & Red wavelength More Effective in Photosynthesis

→ T.W Engleman → First Action Specturum (Graph B/w O_2 produc & wavelength)



(Action Specturum)

(This Action specturum Similar to Absorptim specturum (wavelength of Chl a & Chl b & Absorb wavelength)



Absorptim Specturum

T. W Engleman

Now consider the interesting experiments done by T.W Engelmann (1843 – 1909). Using a prism he split light into its spectral components and then illuminated a green alga, *Cladophora* placed in a suspension of aerobic bacteria. The bacteria were used to detect the sites of O_2 evolution. He observed that the bacteria accumulated mainly in the region of blue and red light of the split spectrum. A first action spectrum of photosynthesis was thus described. It resembles roughly the absorption spectra of chlorophyll *a* and *b* (discussed in section 11.4).

Van neil → Microbiologist → Studying → nutrition in Bacteria

Initial Equation of photosynthesis → $6CO_2 + 6H_2O \longrightarrow C_6H_{12}O_6 + 6O_2$

$CO_2 + H_2O \longrightarrow (CH_2O)_6 + O_2$ (Empirical Equation)

Van neil → H_2O is a source of Hydrogen

Certain Oxidizable compound Give Hydrogen to CO_2 & Glucose Form

$H_2A + CO_2 \longrightarrow CH_2O + 2A$

(H_2O, H_2S) — Glucose

Most plants → H_2A is H_2O ✓

Q In Bacteria → Green Sulfur Bacteria → (H_2S is Hydrogen donor)

H_2O is Hydrogen Donor – By product → O_2

H_2S is Hydrogen Donor → By Product → Sulfur & Sulphate

Two observation

① Role of water → Donor of hydrogen ⟶ By Product oxygen (Oxygenic)
In some bacteria (Green Sulfur Bacteria, purple sulfur Bacteria donor of Hydrogen is H_2S ⟶ By product is Sulfur (Anoxygenic)

② Corrected Equation ⟶

✗ $6CO_2 + 6H_2O \longrightarrow C_6H_{12}O_6 + 6O_2$ [Problem → 12O → RHS, In water → 6O → LHS]

✓ $6CO_2 + 12H_2O \longrightarrow C_6H_{12}O_6 + 6O_2 + 6H_2O$ ✓

[All Oxygen produce Come from water

This can be Proved By – Radio isotope – We use $H_2O(O^{18})$ ⟶ come out as O_2
We use $H_2O(H_1^3)$ ⟶ Glucose Appear Radioactive
Hydrogen go into Glucose

Q In Radioisotop technique $CO_2(O^{18})$ than

(a) H_2O Radioactive in Substrate

(b) Glucose Radioactive

(c) O_2 Radioactive

(d) none

$$CO_2 + H_2O \longrightarrow C_6H_{12}O_6 + O_2$$

Van neil

By the middle of the nineteenth century the key features of plant photosynthesis were known, namely, that plants could use light energy to make carbohydrates from CO_2 and water. The empirical equation representing the total process of photosynthesis for oxygen evolving organisms was then understood as:

$$CO_2 + H_2O \xrightarrow{\text{Light}} [CH_2O] + O_2$$

where $[CH_2O]$ represented a carbohydrate (e.g., glucose, a six-carbon sugar).

Van neil

A milestone contribution to the understanding of photosynthesis was that made by a microbiologist Cornelius van Niel (1897-1985), who, based on his studies of purple and green bacteria demonstrated that photosynthesis is essentially a light-dependent reaction in which hydrogen from a suitable oxidisable compound reduces carbon dioxide to carbohydrates. This can be expressed by:

H_2O / H_2

$$2H_2A + CO_2 \xrightarrow{\text{Light}} 2A + CH_2O + H_2O$$

$H_2O + CO_2$ ... $CH_2O + O_2$

In green plants H_2O is the hydrogen donor and is oxidised to O_2. Some organisms do not release O_2 during photosynthesis. When H_2S, instead is the hydrogen donor for purple and green sulphur bacteria, the 'oxidation' product is sulphur or sulphate depending on the organism and not O_2. Hence, he inferred that the O_2 evolved by the green plant comes from H_2O, not from carbon dioxide. This was later proved by using radioisotopic techniques. The correct equation, that would represent the overall process of photosynthesis is therefore:

$$6CO_2 + 12H_2O \xrightarrow{\text{Light}} C_6H_{12}O_6 + 6H_2O + 6O_2$$

where $C_6H_{12}O_6$ represents glucose. The O_2 released is from water; this was proved using radio isotope techniques. Note that this is not a single reaction but description of a multistep process called photosynthesis.

Can you explain why twelve molecules of water as substrate are used in the equation given above?

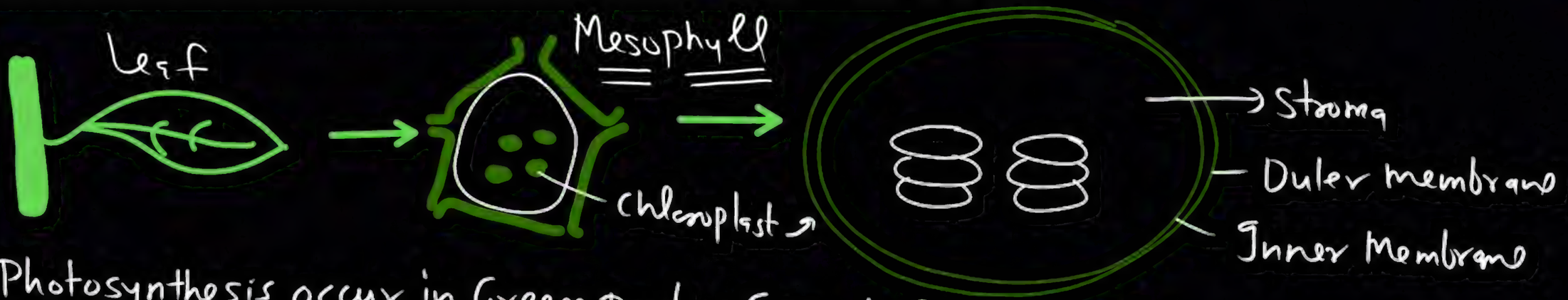
Oxidn

H_2O, H_2S

O_2 S

CO_2

Location of Photosynthesis

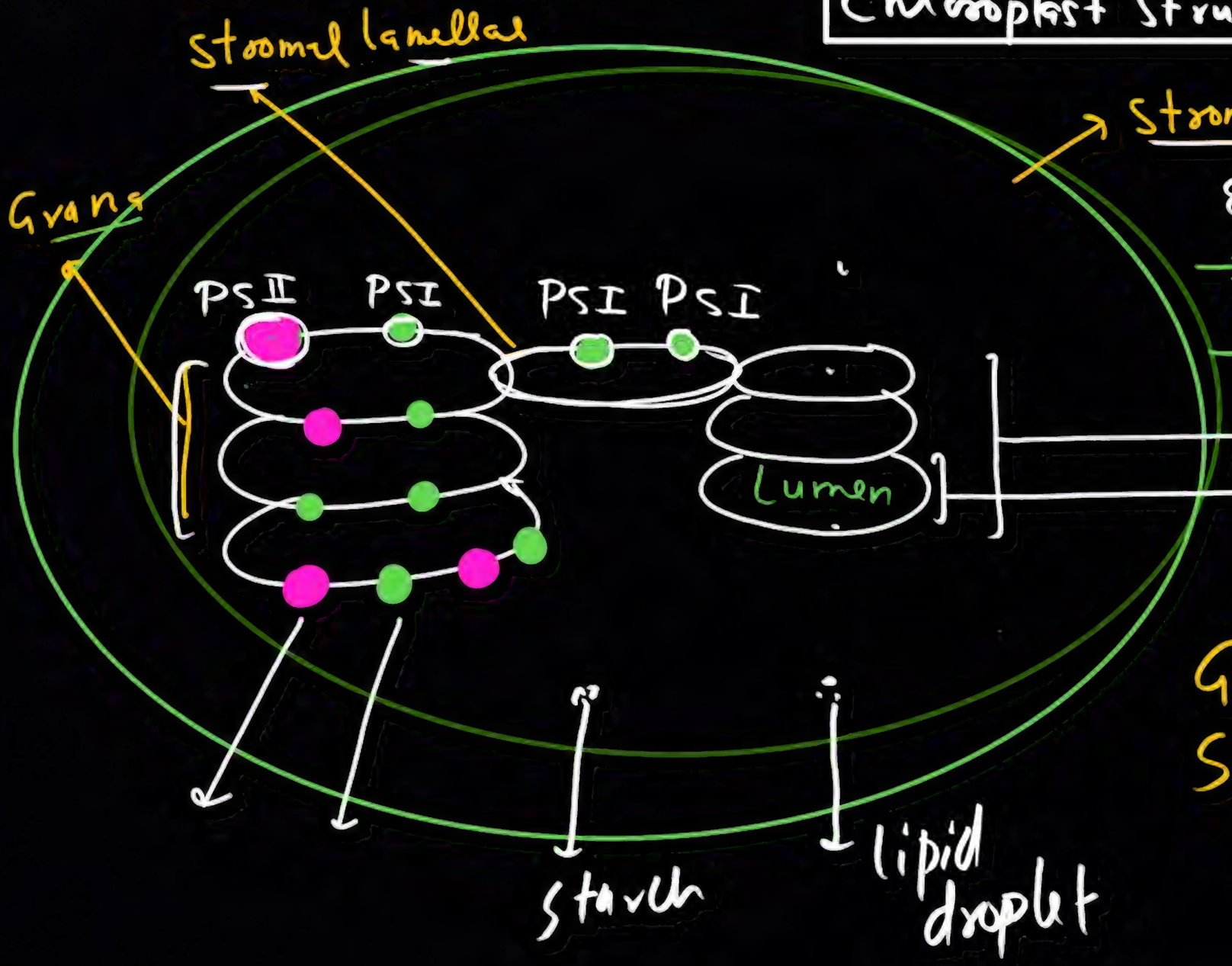


→ Photosynthesis occur in Green part → Green leaf & Green stem
→ Leaf have Mesophyll cell → Chloroplast (20-40) present

note - Eukaryotic cell show cytoplasmic streaming due to which change in position occur.

→ Chloroplast position can get change with light
→ Flat surface parallel to cell wall - Evening

Chloroplast structure



Stroma → ds DNA, Circular DNA
70 s Ribosome
Enzyme – Dark Reaction

→ Outer membrane

→ Inner Membrane

→ Granum (Piles of thylakoid)

→ Thylakoid
(Pigment present)

Granal thylakoid – PS II & PS I
Stromal thylakoid – PS I

Chloroplast structure

→ Chloroplast – Double Membrane organelle

→ Stroma → Fluid matrix, DNA, RNA & Protein Present, Ribosome – 70S

→ Membrane System → thylakoids pigments attached

↑— Thylakoid → Granal thylakoid & Stromal lamella

Division of labour

In chloroplast → [Light & Dark Rxn location Different]

(a) Membrane system / thylakoids → Pigment attach, So Light Reaction occur (Photochemical Phase) → H_2O Break, O_2 produce, NADPH & ATP Form

(b) Stroma → Dark Reaction (Biosynthetic) → Sugar Form (Enzyme present) Reduction of CO_2 occur

Q Not occur in Stroma

(a) Biosynthetic phase (b) Photolysis (c) Glucose From (d) Protein Synthesis

(CO2 → Glucose) (H2O Break) (As DNA)

DOPA number-01

Q1 Proof For Photosynthesis
(a) O_2 Evolve (b) Starch presence (c) CO_2 use (d) Both a & b

Q2 Plant part inside test tube in half leaf Expriment
(a) Non Green (b) Not get light (c) not get CO_2 (d) Starch positive

Q3 Mint plant can Restore Air quality which was destroyed By
(a) Plant (b) Breathing Animal (c) Burning candle (d) Both b & c

Q4 Green plant in Bright Light produce Oxygen Bubble proof By
(a) Ingenhouss (b) Priestley (c) Van neil (d) Engleman

Q5 Soure of Oxygen is H_2O is proved By
(a) Ingenhouss (b) Priestley (c) Englman (d) Van neil

Q6 In Experiment of T.W Engleman mark correct

(a) Cladophora – aerobic & anoxygenic (b) Aerobic bacteria – attract most towards yellow

(c) Cladophora – Oxygenic (d) none

Q7 If Radioactive Glucose tested For Radioactivity, Name H_1^3

then this come From ____ in higher plant

(a) CO_2 (b) H_2O (c) H_2S (d) Both b & c

Q8 Which is Oxygenic

(a) higher plant (b) Nostoc

(c) Euglenoids (d) all

Q9 Not occur on thylakoid

(a) Photolysis (b) Pigments (c) Sugar Form (d) Chlorophyll Absorb light

Q10 Division of labour means in chloroplast

(a) Membrane system present (b) Chloroplast with stroma

(c) Stroma with Dark Rxn & thylakoid with light Rxn (d) None

Q11

S-I. Oxygenic Algae Cladophora use in T.W Engleman Experiment

S-II Van neil proved H_2O is only oxidizable compound

Q12 → S-I → In H_2O, if H is Radioactive appear in Glucose

S-II → In H_2O, if O is Radioactive Appear in Oxygen

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Photosynthesis in higher plants

lecture - 03

Botany

TARUN SIR

Topics

(Summary - Smart one shot)

1. Experiments

2. location of Photosynthesis
   type of pigments
   Light Reaction
   Chemiosmotic hypothesis

2. Dark Reaction
   photorespiration
   C-4 plants

1. Factors Affecting Photosynthesis

ISO → FEG

3-4 Q (conceptual Question)

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First Action spectrum Form → Similar to Absorption spectrum of Chla & Chlb
6

(g) Van neil
1
→ O_2 produce in photosynthesis come From H_2O
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H_1^3 → Glucose – $C_6H_{12}O_6$

(a) CO_2 (b) H_2O (c) H_2S (d) Both b & c

Q8 Which is Oxygenic

(a) higher plant (b) Nostoc

(c) Euglenoids (d) all

(Protista - Diatom, Dino, Euglena

Q9 Not occur on thylakoid

(a) Photolysis (b) Pigments (c) Sugar From (d) Chlorophyll Absorb light

$H_2O \rightarrow H + O \rightarrow O_2$

Glucose

Q10 Division of labour means in chloroplast

(a) Membrane system present (b) Chloroplast with stroma

(c) Stroma with Dark Rxn & thylakoid with light Rxn (d) None

Q11

S-I : Oxygenic Algae Cladophora use in T.W Engelman Experiment ✓ only 4

S-II Van neil proved H_2O is only oxidizable Compound ✗]

Q12 → S.I → In H_2O, if H is Radioactive appear in Glucose ✓

S-II → In H_2O, if O is Radioactive Appear in Oxygen ✓ Both correct products

Light Reaction

- About pigment ✓
- How pigment Function ✓
  - → Photosystem ✓
  - → Non cyclic ē Flow
    Cyclic ē Flow ✓
  - → Chemiosmotic hypothesis ✓

About Pigments

Pigments – Chemical compound – Absorb Fix wavelength of light and Excite $\bar{e}$

Type of Pigments – Divide into two category

(a) Soluble in water → Ex– Anthocyanin, Phycoerythrin, Phycocyanin

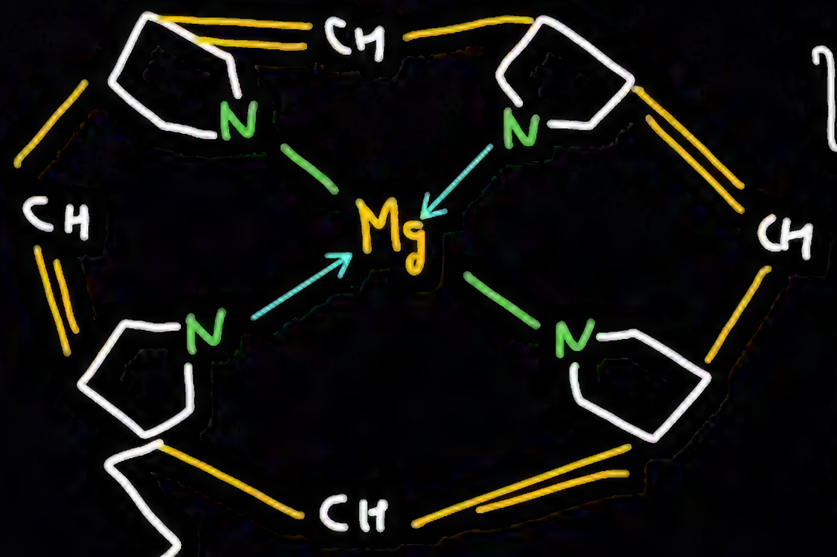
(b) Soluble in organic solvent → (a) Chlorophyll (higher plant Chlorophyll two type, Chlorophyll b ($C_{55}H_{70}O_6N_4Mg$))
(Nature is lipid)

Chla – $C_{55}H_{72}O_5N_4Mg$

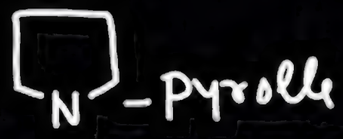
(CH_3 Group Replaced By CHO in Chl b)

Chl a

Note – higher Plant chla & chl b



Porphyrin head → 4 pyrol present
(35 carbon) 1 Mg



– Pyrolle

Similar structure is of Heme
(in place of Mg → Fe present)

20 C → tail
(Phytol tail)

→ Chlorophyll → two part – (a) Porphyrin head
(b) Phytol tail

Q Structure of chlorophyll similar to heme
(a) Complete structure (b) Porphyrin head (c) Phytol tail (d) none

Q Mineral Absent in chlorophyll
(a) N (b) Mg (c) Fe (d) all

(b) Carotenoids (other than Green)

two type

(i) Carotene (orange, Red) — C-C-C-C-C-C

Ex - β-Carotene - Carrot (orange)

Lycopene → tomato (Red)

Vit-A → 20C

Carotene - 40C

Q How many Vit-A Produce From Carotene

(a) Five (b) ten

(c) 15 (d) none

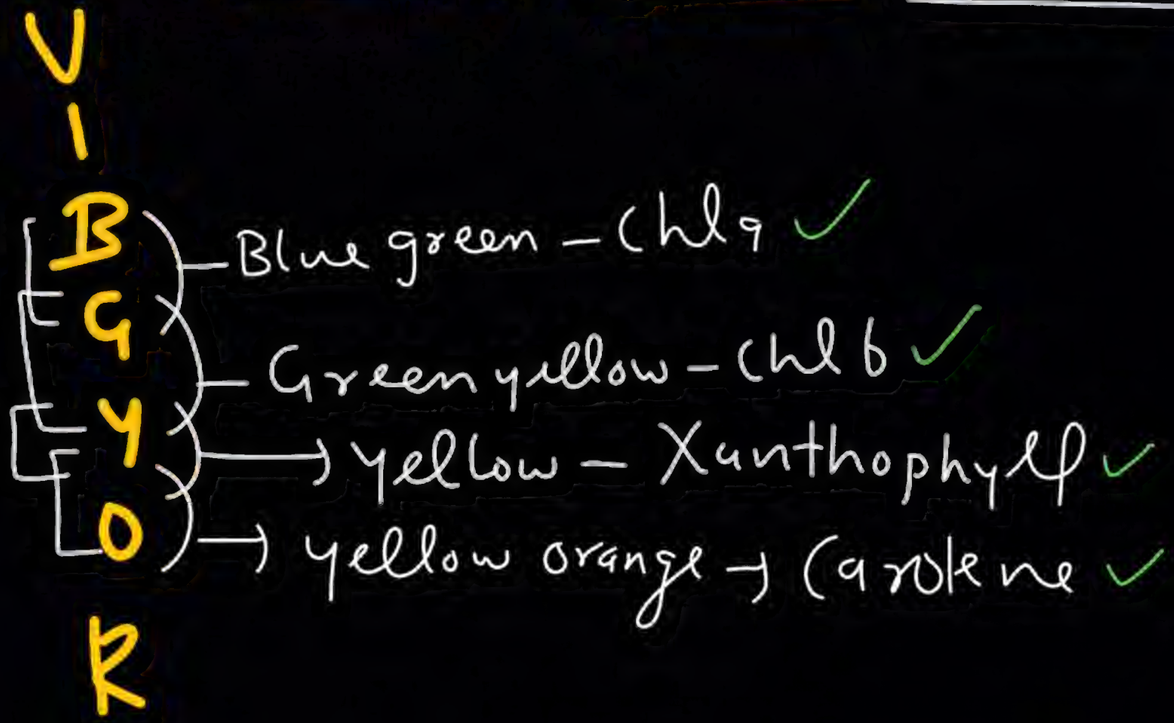
(ii) Xanthophyll (Yellow)

→ Brown - Fucoxanthin → Ex - Brown Algae

→ Lutein → Yellow ; Ex - yellow leaf Maize

Chlorophyll	Carotenoids
- Green	- Yellow, orange, Red
→ Ring (Porphyrin	+ Straight chain

Colour of Pigments - NCERT



Vit-A-20%

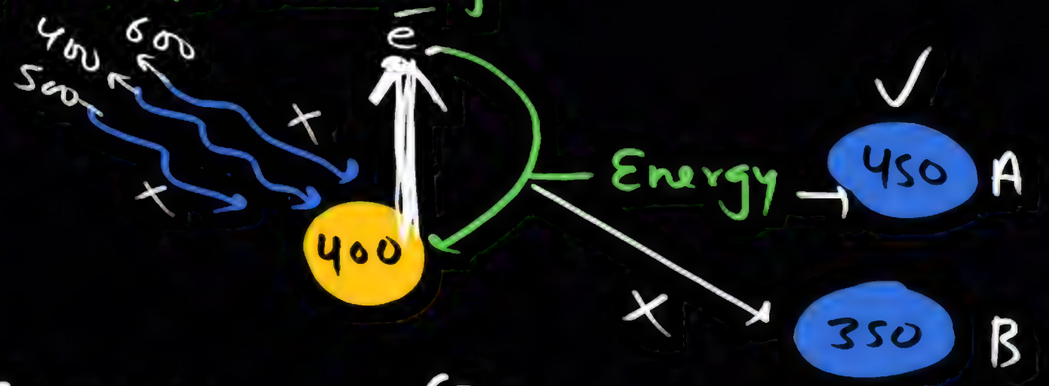
Carotene-40%

Q 5 molecule carotene no. of vit-A

(a) 10 (b) 15

II How Pigment Function

- Pigment chemical compound — Excite $\bar{e}$ → Fix wavelength
- When $\bar{e}$ is Excited ⟶ Two option



I (a) $\bar{e}$ comeback to Ground state & Release Energy

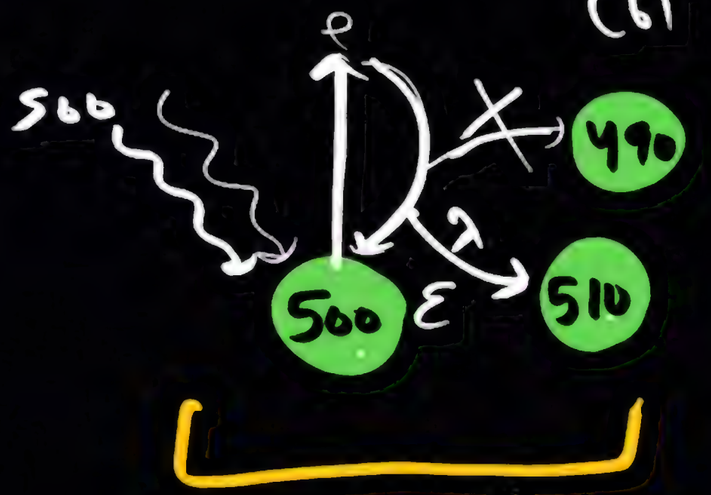
(Energy decrease ⟶ wavelength Increase
that wavelength can be Accepted By other pigment (higher wavelength) (Pigment can transfer wavelength to other pigment

$E \propto \frac{1}{\lambda}$ → E dec., λ Inc.

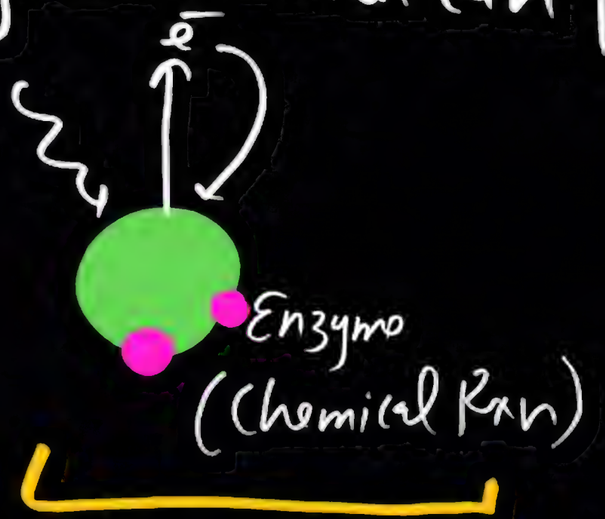
II Pigment excite $\bar{e}$ → Perform chemical Rxn = Photochemical Rxn (like – H_2O Break → NADPH Form).

→ Type of pigment → (a) chl a (b) chl b (c) Carotene (d) Xanthophyll
(On the Basis of structure)

→ Type of pigment → on the Basis of Function — Two type
(a) Pigment tranfer wavelength to other pigment
(b) Pigment which can perform some Reaction



- no Reaction Perform
- tranfer Energy to other pigment



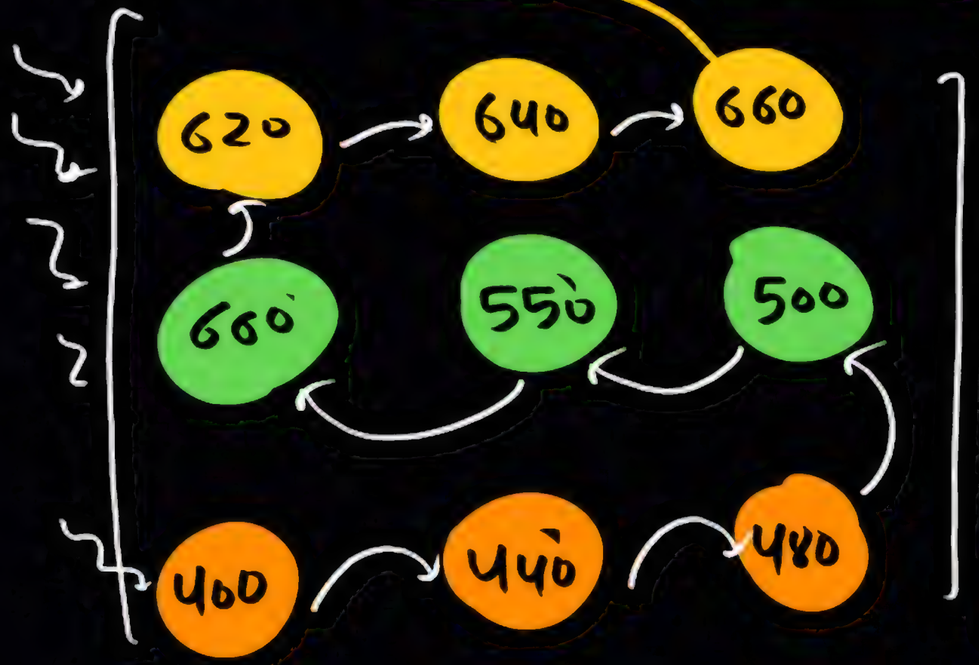
Reaction perform

Q Which pigment work at lowest Energy
(a) 400 nm (b) 500
(c) 600 (d) 680

How pigment Arrange

$\varepsilon \propto \frac{1}{\lambda}$

[Chla
680
main pigment (Rxn centre) | Rxn centre Photochemical Rxn] — highest wavelength (Energy lowest)



Antenna molecule | Accessory Pigment
(Excite $\bar{e}$ & Energy tranfer to Another pigment (higher wavelength)

Chlb, Carotene Xanthophyll

note –
- Rxn centre Always Chla
- Rxn centre work at highest wavelength

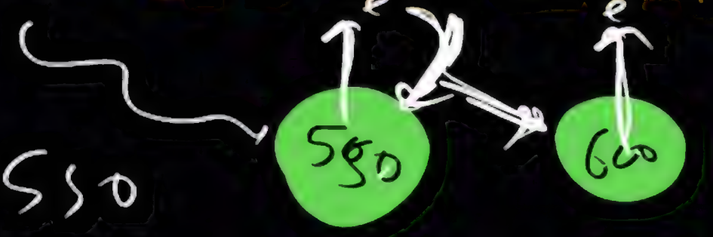
Q1 Which pigment work at lowest Energy (Highest wavelength)

(a) Chl a (b) Chl b (c) Carotene (d) Xanthophyll

Q Two pigment → A - 550nm B = 600 nm (Both present together)

Wavelength 550nm → ē Excite From

(a) None (b) only A (c) Both A & B (d) only B



Q Two pigment → A = 600nm B = 650 nm (Both present together)

Wavelength 650nm

(a) None (b) Only A (c) Both A & B (d) Only B

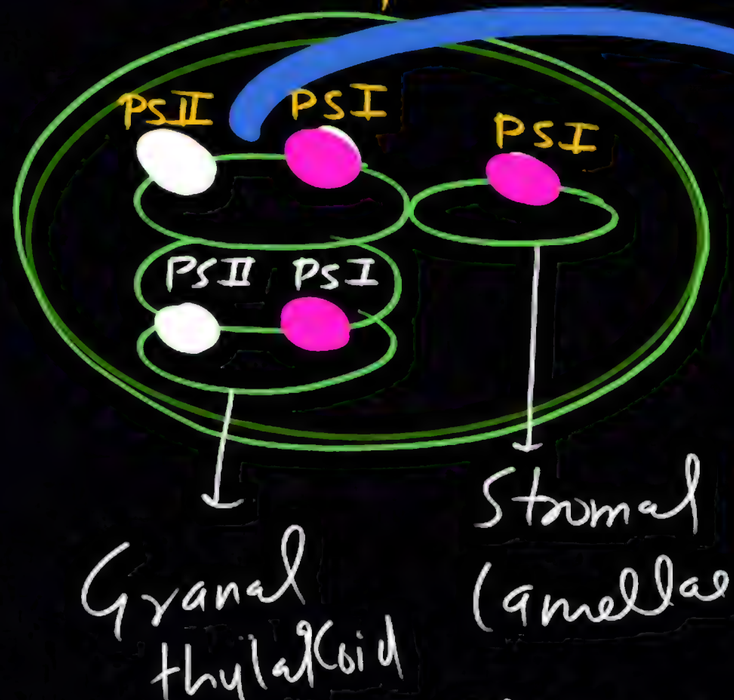
What is photosystem

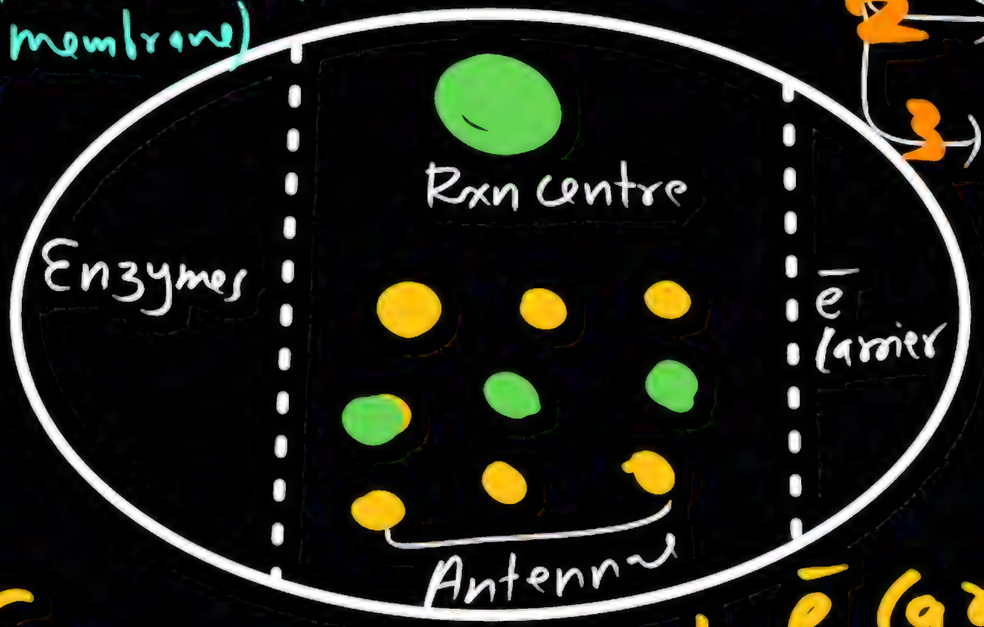
PS → two type – PS I & PS II

– Pigments are not present Randomly on thylakoid Membrane

→ They are present in Form of Functional unit – **Photosystem**

(Present on thylakoid membrane)





→ Light Harvesting Complex (LHC)
Chl a + Antennae

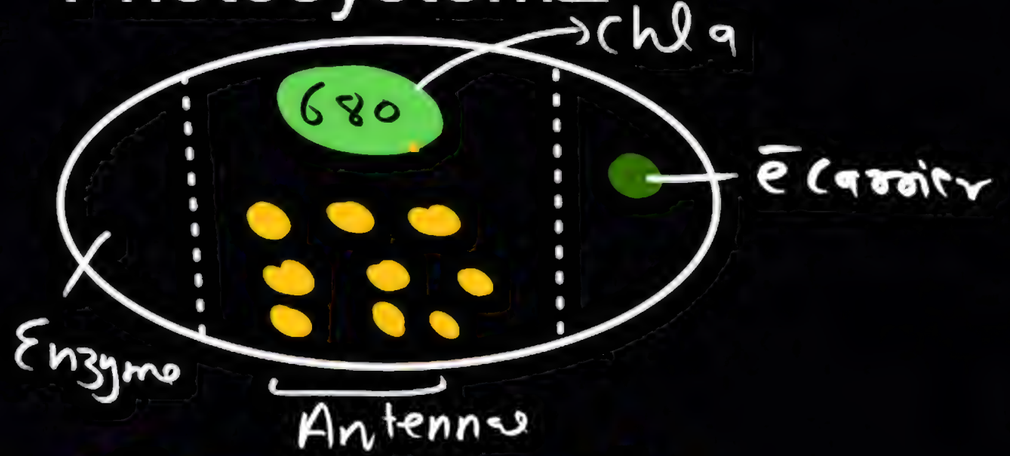
→ Enzymes.

→ e⁻ carrier

Photosystem = Enzymes + LHC + e⁻ carrier

Two type of Photosystem

Photosystem II

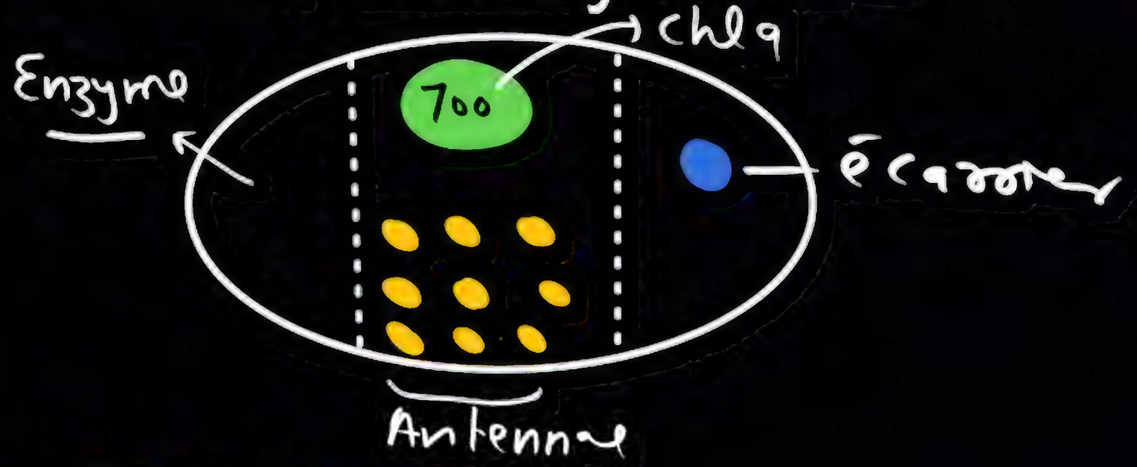


→ Second discovered

→ Rxn centre = Chl a → Absorb at 680 nm
↳ P^{680} = Chl a

→ Active at wavelength Below 680 nm & at 680 nm

Photosystem I



→ First Discovered

→ Rxn centre → Chl a → Absorb at 700 nm
P^{700} → Chl a work at 700 nm

→ Active at 700 nm & below

Q At wavelength 630 nm

(a) PS I Active (b) PS II Active (c) Both Active (d) none

Q At wavelength – 681 nm

(a) PS I Active (b) PS II Active (c) Both (d) none

Wavelength	Absorb by ✓	PS I Active	PS II Active
(a) 450 nm	Antenna PS I, Antenna PS II	✓	✓
(b) 660 nm	Same	✓	✓
(c) 680 nm	Antenna of PS I, Rxn centre of PS II	✓	✓
(d) 681 nm	Antenna of PS I	✓	X
(e) 700 nm	Rxn centre of PS I	✓	X
(e) 701 nm	X	X	X

PS II - Active - Below or at 680 nm

PS I Active - Below or at 700 nm

Both Acting - Below 680 nm

PAR - 400 - 700 nm

Lowest Antenna

Rxn Centre of PS I

DOPA-02

01 Antennae present in all Except
(a) LHC (b) PS (c) Rxn centre (d) thylakoid

02 Sunlight can Excite ē of
(a) Antennae (b) Rxn centre (c) Both (d) none

03 Rxn centre - not true
(a) Work at lowest Energy (b) Always chla (c) work at highest wavelength (d) Pass Energy to Antennae

04 Carotene is
(a) Antennae in all Autotroph (b) Rxn centre in Algae (c) Antennae in Higher plant (d) not Absorb light

05 Green Algae & Red Algae have Similarity in
(a) Antennae (b) Rxn centre (c) Flagella (d) all

Q6 Which is not true

(a) PS II chlorophyll is Both Rxn centre & Antennas (b) PS I Reaction centre is P^{700}

(c) PS II Rxn centre P^{680} (d) Chl b antennas in PS I not in PS II

Q7 Sunlight can Excite $\bar{e}$ in

(a) Antennas (b) Rxn centre (c) Both (d) none

Q8 Which is not correct Direction of Energy Among Pigments

(a) PS II to PS I (b) Antennas to P^{700nm} (c) Antennas to P^{680} (d) PS I to PS II

Q9 which work at lowest Energy

(a) P^{680} (b) P^{700} (c) Antennas of PS I (d) Antennas of PS II

Q10 Not Part of PS II

(a) P^{680} (b) Antennas at 640nm (c) Antennas at 680nm (d) $\bar{e}$ Acceptor

Q11 At wavelength 701 nm

(a) PS I Active (b) PS II Active (c) Both Active (d) NO PS Active

Q12 At 630 nm _____ Absorb wavelength

(a) Antennae of PS I (b) Antennae of PS II (c) Rxn centre of PS I (d) None

Q13 Three pigments → A–400 B = 600 C = 450 D = 620

At wavelength 450 nm Direction

(a) B C D (b) C B D (c) A C B D (d) None

Q14 Enzymes are associated with

(a) Rxn centre (b) Antennae (c) Both (d) None

Q15 LHC in PSII → (a) Antennae (b) Chl b (c) Chl a (d) all

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Photosynthesis in higher plants

lecture - 04

Botany

TARUN SIR

Topics

(Summary – Smart one Shot)

1 [Experiments]

2 [
- location of Photosynthesis
- type of pigments
- Light Reaction
- Chemiosmotic hypothesis
]

2 [Dark Reaction
photorespiration]

C-4 plants

1 [Factors Affecting Photosynthesis]

[ISO → FEG]

3-4 Q (conceptual Question)

List of Experiments

1 (a) Variegated Leaf
2 (b) KOH - half leaf
→ Result - Green Area - Photosynthesis occur in presence of light

→ CO_2 is Important For Photosynthesis

3 (c) Bell Jar (Priestley) (1770) Experiment
→ Mice & Candle - Damage Air Quality
→ Mint plant - Restore Air Quality (O_2 produce)

4 (d) Ingenhousz
→ Light is Important
→ High light intensity can produce O_2 Bubble

5 (e) Von Sach (1854)
→ Plant Grow → In Green Area - Glucose Form Store in Form of Starch

6 (f) T.W Engleman
→ Light split → Spectral component → Blue & Red wavelength - More photosynthesis
→ First Action spectrum Form → Similar to Absorption spectrum of Chla & Chlb

7 (g) Van neil
→ O_2 produce in photosynthesis come From H_2O
→ H_2S is Donor of Hydrogen
→ Equation Corrected For photosynthesis ($6CO_2 + 12H_2O \rightarrow C_6H_{12}O_6 + 6O_2$)
→ Verified By - Radio isotope technique

DOPA number-01

Q1 Proof For Photosynthesis
(a) O_2 Evolve (b) Starch presence (c) CO_2 use (d) Both a & b

Q2 Plant part inside test tube in half leaf Expriment
(a) Non Green (b) Not get light (c) not get CO_2 (d) Starch positive

Q3 Mint plant can Restore Air quality which was destroyed By
(a) Plant (b) Breathing Animal (c) Burning candle (d) Both b & c

Q4 Green plant in Bright Light produce Oxygen Bubble proof By
(a) Ingenhouss (b) Priestley (c) Van neil (d) Engleman

Q5 Soure of Oxygen is H_2O is prooved By
(a) Ingenhouss (b) Priestley (c) Englman (d) Van neil

Q6 In Experiment of T.W Engleman mark correct

(a) Cladophora – aerobic & anoxygenic (b) Aerobic bacteria – attract most towards yellow

(c) Cladophora – Oxygenic (d) none

Q7 If Radioactive Glucose tested For Radioactivity, Have H_1^3 then this come From ____ in higher plant

H_1^3 → Glucose – $C_6H_{12}O_6$

(a) CO_2 (b) H_2O (c) H_2S (d) Both b & c

Q8 Which is Oxygenic

(a) higher plant (b) Nostoc

(c) Euglenoids (d) all

(Protista - Diatom, Dino, Euglena)

Q9 Not occur on thylakoid

(a) Photolysis (b) Pigments (c) Sugar From (d) Chlorophyll Absorb light

$H_2O \rightarrow H + O \rightarrow O_2$

Glucose

Q10 Division of labour means in chloroplast

(a) Membrane system present (b) Chloroplast with stroma

(c) Stroma with Dark Rxn & thylakoid with light Rxn (d) None

Q11

S-I : Oxygenic Algae Cladophora use in T.W Engelman Experiment only 4]

S-II Van neil proved H_2O is only oxidizable Compound ✗

Q12 → S-I → In H_2O, if H is Radioactive appear in Glucose ✓

S-II → In H_2O, if O is Radioactive Appear in Oxygen ✓ Both correct molecule

Light Reaction

- About pigment ✓
- How pigment Function ✓
  - → Photosystem ✓
  - → Non cyclic ē Flow
    Cyclic ē Flow ✓
  - → Chemiosmotic hypothesis ✓

Wavelength	Absorb by ✓	PS I Active	PS II Active
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(c) PS II Rxn centre P^{680} ? Antennae (d) Chl b antennae in PS I not in PS II

6 - 4

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PS I → 680 PS II → 700 Q 86

Q13 Three pigments → A = 400 B = 600 C = 450 D = 620

At wavelength 450 nm Direction

450 → 600 → 620
C B D

(a) B C D (b) C B D (c) A C B D (d) None

Q14 Enzymes are associated with

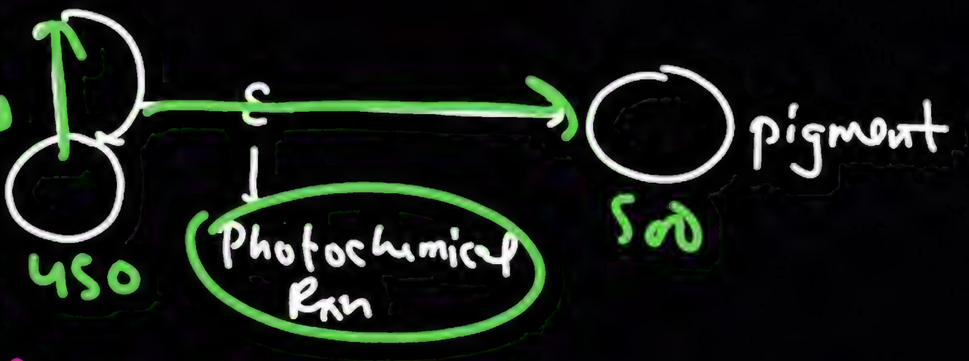
(a) Rxn centre (b) Antenna (c) Both (d) None

Q15 LHC involve → (a) Antenna (b) Chl b (c) Carotene (d) all

last Class Revision

→ Pigments → chemical compound

→ Type - Chla, Chlb, carotenoids, Xanthophylls

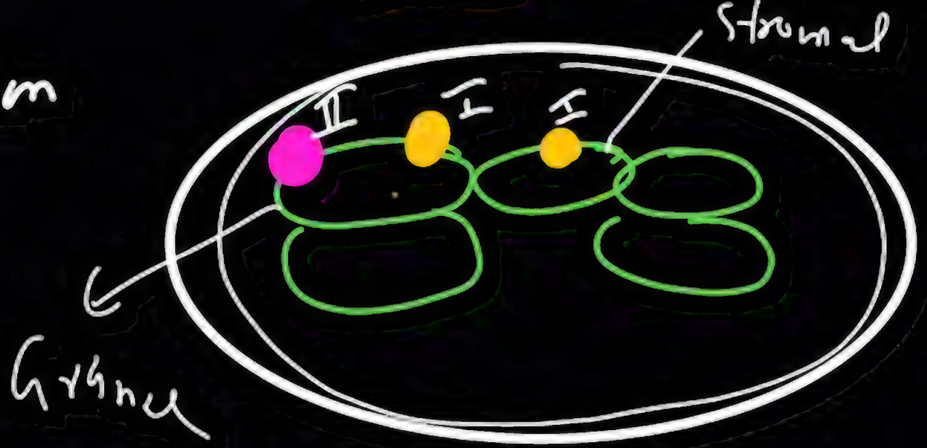


→ on the Basis of Function
- Rxn centre — Chla
- Antennae — Chlb, Carotenoids, Xanthophylls — LHC

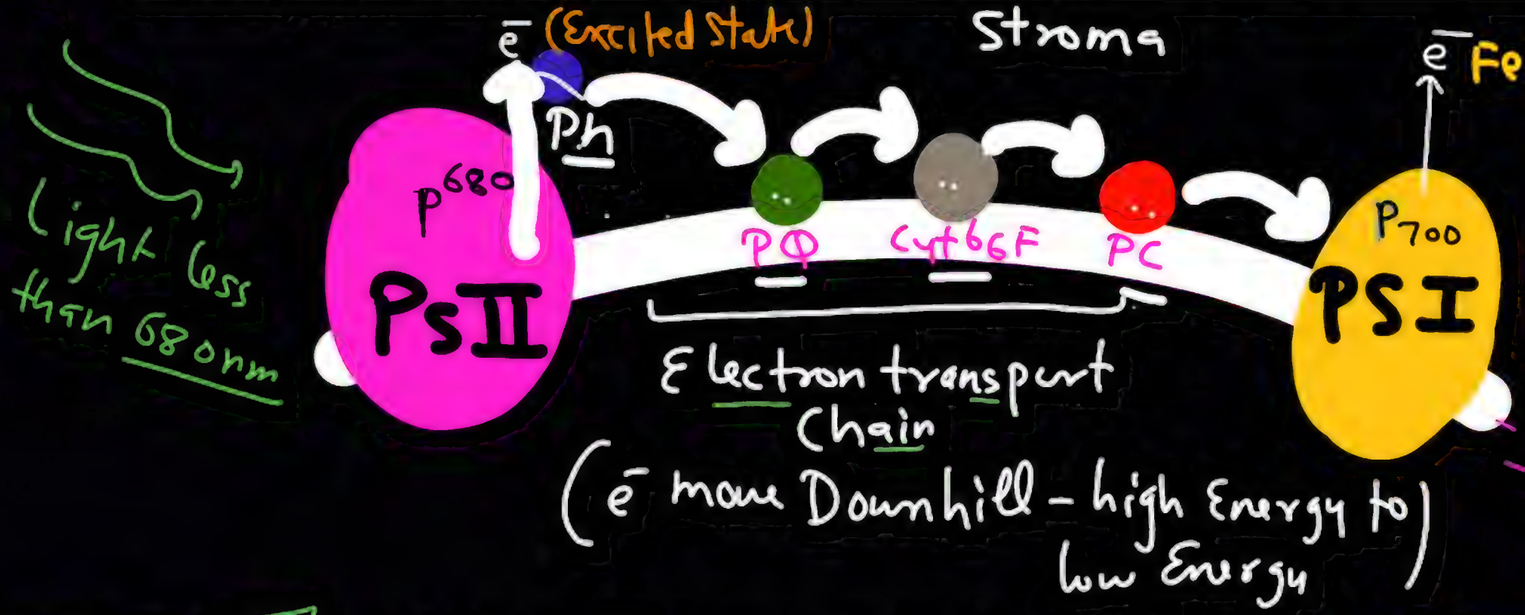
→ Photosystem
- Pigments
  - Rxn centre ✓
  - Antennae ✓
- e⁻ carrier
- Enzyme

PS II ✓	PS I ✓
Discovery - Second	First
Rxn centre Chla P^{680}	Chla P^{700}
Grana thylakoid	Grana & Stroma lamellae

→ location



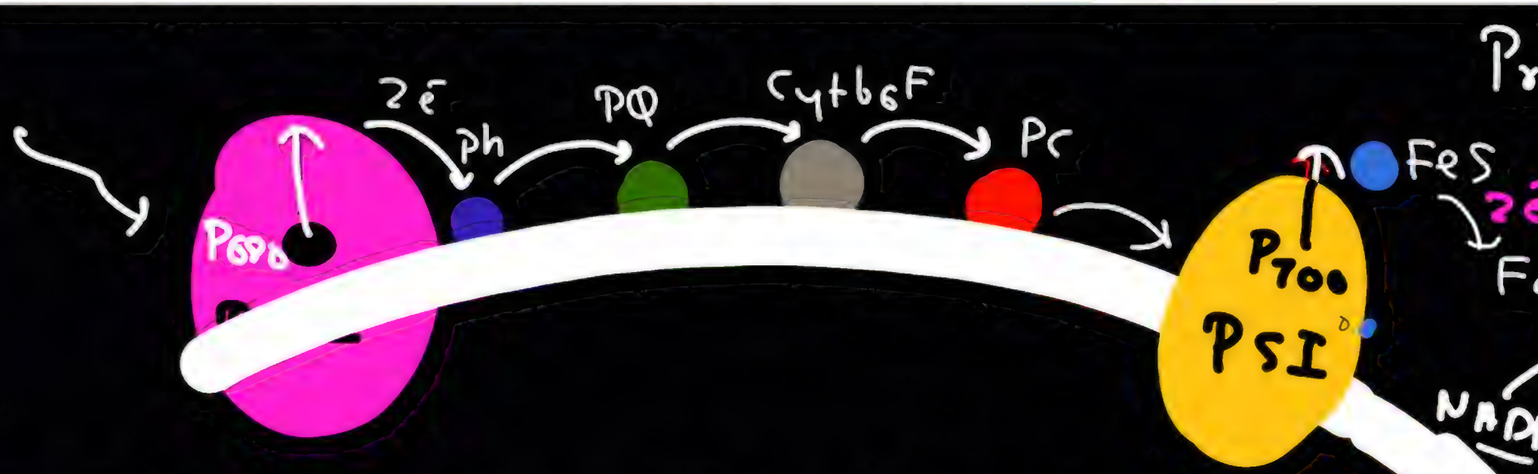
Electron Flow through photosystem



- Light → less than 680 nm (Both PS Active)
- Photosystem exite - Both
- Primary Acceptor of Photosystem → PSII - Phaeophytin, PSI → Fes
- e⁻ Carrier B/w PS II & PS I
  - Phaeophytin
  - Plasto Quinone
  - Cytochrome b6F
  - Plastocyanin

- Ph - Phaeophytin - Primary e⁻ Acceptor of PS II → P
- PQ - Plasto Quinone → Q
- Cyt b6F → Cytochrome b6F → C
- PC → Plastocyanin → P

Electron Flow through photosystem



Primary Acceptors of PS I → Fes → Fes Pass ē to Fd - Ferrodoxin

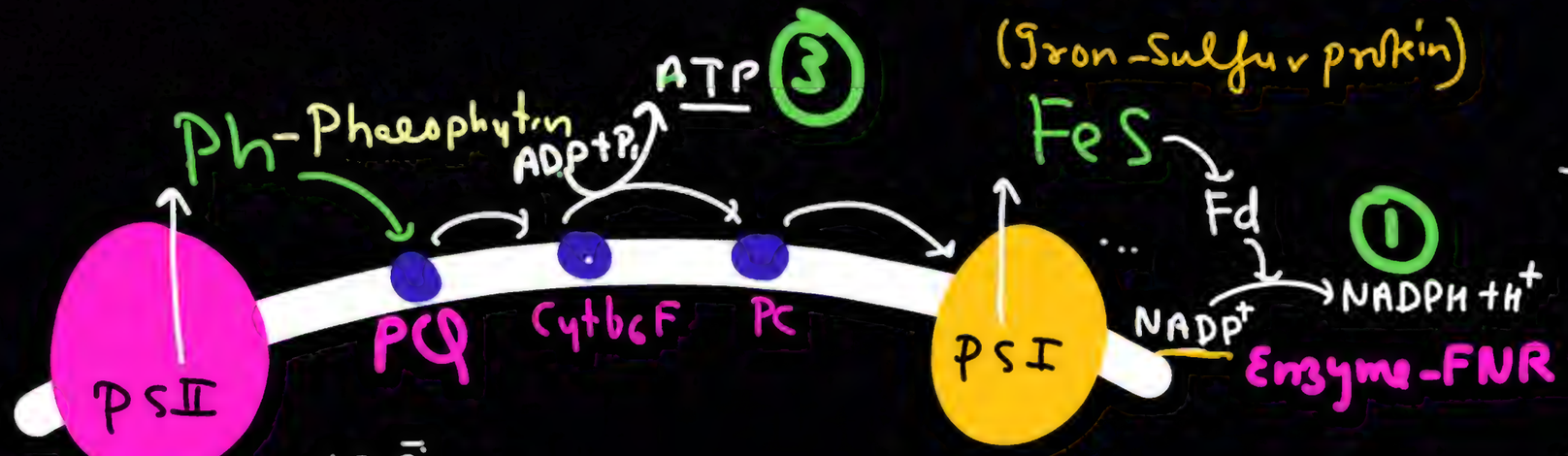
→ PS II to ē move to PS I - through ETC (Electron transport Chain

→ PS I → ē → Fes → Fd → NADP+ → NADPH

Enzyme - FNR - Ferrodoxin NADP Reductase

→ $NADP + \bar{e} + H^+ \xrightarrow{Red} NADPH$

→ $NADP^+ + 2\bar{e} + 2H^+ \longrightarrow NADPH + H^+$



→ PS I - take e⁻ From PS II when it is e⁻ deficient

→ PS II Break (oxidise) Water & take e⁻

Q PS II Break water

(I) PS II is in oxidised (e⁻ deficient)

(II) PS II is in Reduced (e⁻ present)

Steps In ē Flow — Product → NADPH, ATP, O_2

(a) Wavelength exite ē in Both Photosystem together - less than 680

(b) Both PS Excited together →

(c) Primary Acceptor of PS II is Pheophytin and of PS I is Fes

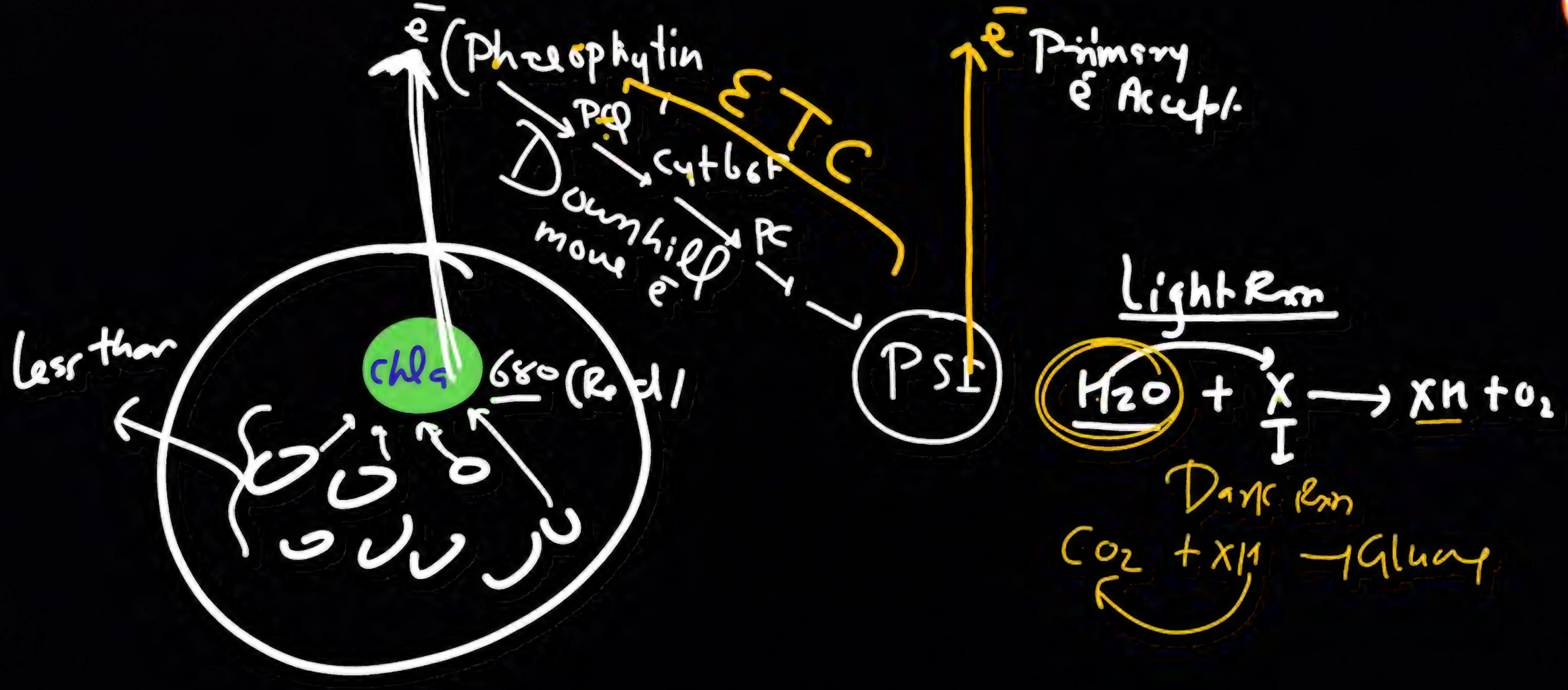
(d) ē Flow From pheophytin to PS I through ETC (Electron transport chain) Downhill move

(e) ē From PS II is move to PSI through - ETC & ATP synthesis occur

(f) ē of PS I → Fes → Fd → and Finally Reduce $NADP^+$ in NADPH (Enzyme - Ferredoxin NADP Reductase (FNR))

(g) ē from PS I move to $NADP^+$ & From PS II to PSI (Due to which PS II ē deficient)

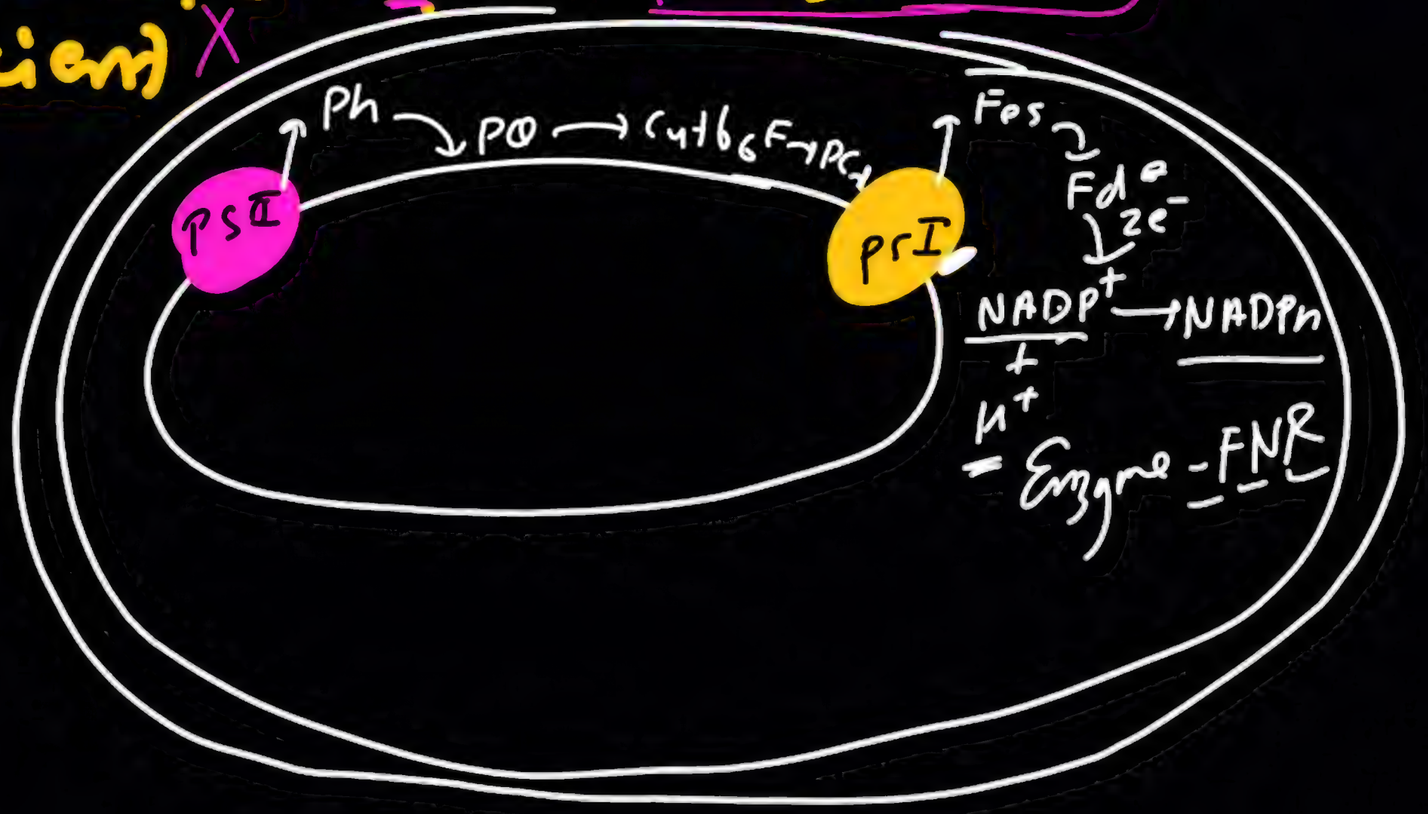
(i) PS II Break (oxidise) water When PS II is ē deficient


e⁻ (Pheophytin
PSII
Cytb6f
ETC
Downhill
movement of e⁻
PC
e⁻ Primary e⁻ Acceptor
Less than
Chla
680 (Red)
PSI
Light Rxn
H2O + X → XH + O2
I
Dark Rxn
CO2 + XH → Glucose

$NADP + H^+ + e^- \longrightarrow NADPH$

$NADP^+ + 2e^- + 2H^+ \rightarrow NADPH + H^+$

(e^- deficient) X



photolysis

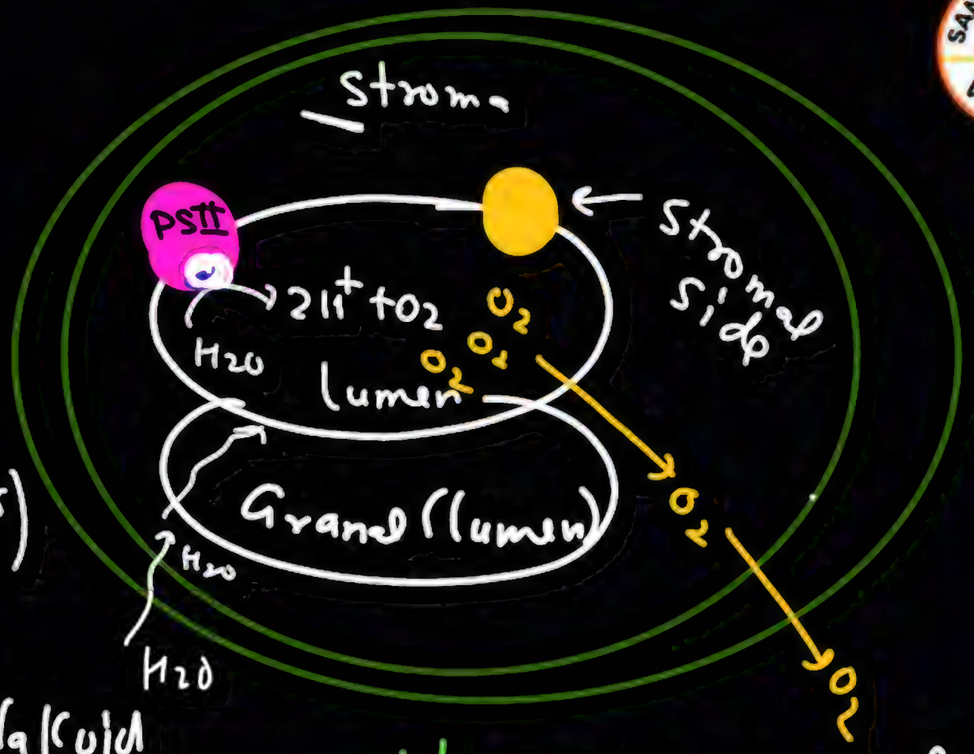
→ Breakdown of water → By PS II

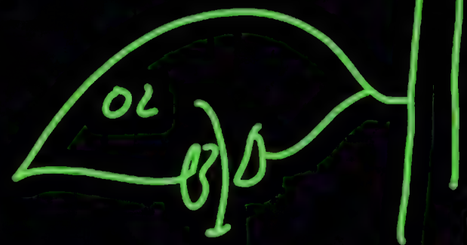
→ PS II → luminal side (thylakoid) → Enzyme For Breakdown of Water

(Mn^{+2}, Cl^- → help in photolysis)

→ Due to which O_2 Form inside → lumen of Granal thylakoid

→ H^+ also Form inside lumen





Q Highest conc. of O_2 is

(a) Stroma of chloroplast

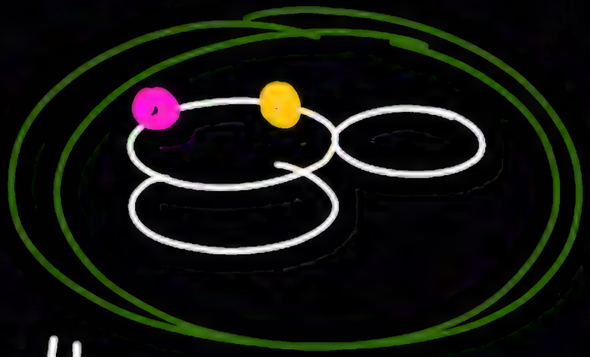
(b) lumen of thylakoid ✓

(c) Inside leaf

(d) Outside leaf

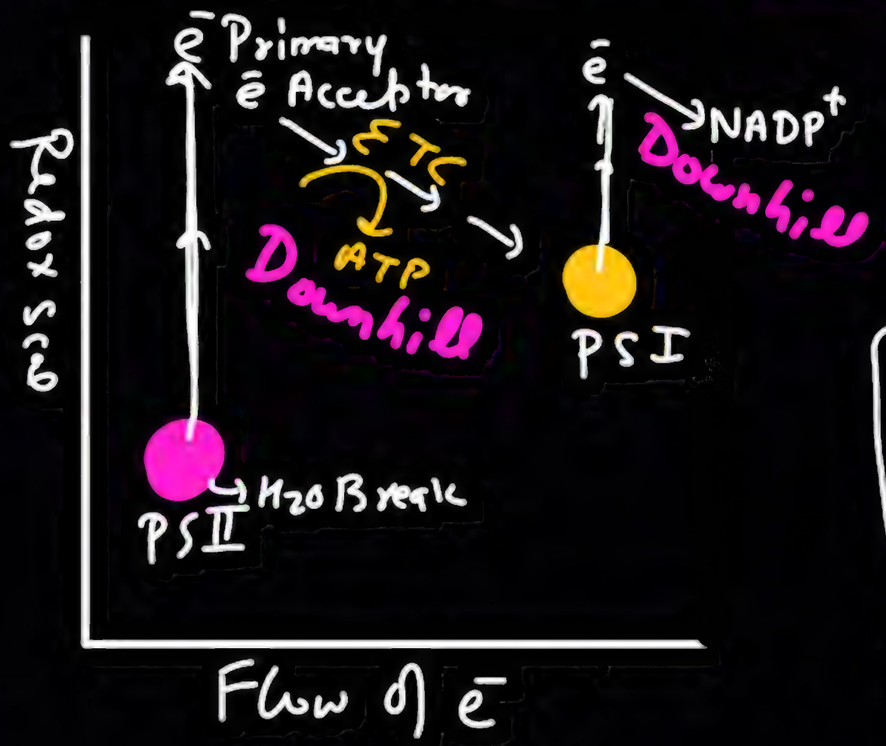
Z-scheme

- If we Draw PS II & PS I → on Redox scale

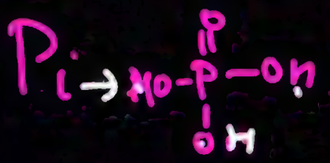


Real

→ Z-shape appear (Z-Scheme)



→ Both PS I & PS II e⁻ Exite → Accepted By Primary e⁻ Acceptor → e⁻ move Downhill



Cyclic and noncyclic Flow of e

→ ATP synthesis → Biological system → ADP is phosphorylate (phosphate add) to make ATP

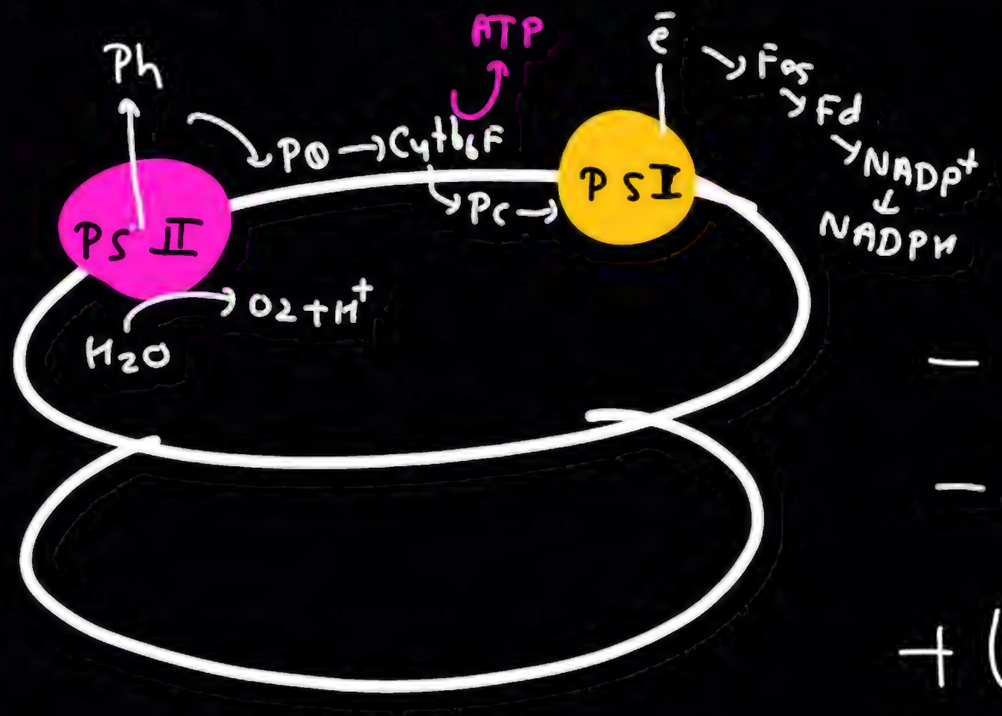
ADP + Pi ⟶ ATP Form (Phosphorylation)

→ In light Rxn, ATP form B/w PS II & PS I (with the energy of e⁻)

ē Excited By → light → Such ATP synthesis → Photo Phosphorylation

Light ATP Synthesis

Non-cyclic Flow of $\bar{e}$



This is non-cyclic Flow of $\bar{e}$

– $\bar{e}$ of PS II & PS I not come back

– Product → O_2, ATP, NADPH

– Granal thylakoid → PS II & PS I
Both involve

+ light less than 680 nm

Cyclic Flow of e^-

— When only PS I is Active

Condition → on Granal thylakoid

Light more than 680 nm

— Stromal only PS I present

Only PS I Active

— When light More than 680 nm

only PS I Active → Fes give e^-

to PQ → $Cytb_6F$ → PC → PS I

→ ATP synthesis

→ O_2 not Frorr

→ NADPH not Frorr

Q FNR Enzyme present

~~(a)~~ Granal thylakoid

(b) Stromal lamella

(c) Both

(d) Stroma

Non cyclic Flow of e^-

Location – Granal thylakoid

Condition → less than 680nm

PS Active → PS I & PS II

→ H_2O Break – Photolysis occur

NADPH Form

ATP Form

PS II → Ph → PQ → Cyt b_6f → PC → PS I

P Q C P

Cyclic Flow of e^-

Location → Granal, Stroma (Always)

↓

More than 680nm

PS Active → only P S I

→ only ATP Form → No photolysis

PS I → Fes → PQ → Cyt b_6f → PC → PS I

F Q C P

DOPA-03

Q1 PS I & PS II Both Active
(a) More than 680 (b) Stromal lamellae (c) Cyclic Flow of $\bar{e}$ (d) none

Q2 Cyclic Flow of $\bar{e}$ not involve
(a) PS I (b) ETC (c) Pheophytin (d) ATP Synthesis

Q3 At 660 nm on Stromal lamellae
(a) Cyclic Flow of $\bar{e}$ (b) FNR Active (c) Pheophytin Active (d) all

Q4 Non Cyclic Flow of $\bar{e}$ not involve
(a) Low PH in granal thylakoid (b) Oxygen Evolution (c) Mn & Ca^{2+} (d) low PH in Stromal lamellae

Q5 PS II involve in photolysis in
(a) Reduced state (b) Oxidised State (c) Both (d) non

Q6 Which occur last
(a) Excitation of Antenna in PS II (b) $\bar{e}$ Excite in Rxn centre (c) PS II Oxidized (d) Photolysis

Q7 Highest conc. of Oxygen in
(a) lumen of thylakoid (b) Stroma (c) inside leaf (d) outer Environment

Q8 For Reduction of NADP which not Require
(a) PS II (b) More than 680 (c) FNR (d) PS I

Q9 NADP is Reduce By
(a) FNR (b) Fd (c) PS II (c) Pheophytin

Q10 In cyclic Flow, Fe$_2$S$_2$ Reduce
(a) PS II (b) PS I (c) Fd (d) NADP

Q11 Stromal lamellae not have
(a) PS II (b) FNR (c) Reduction of NADP (d) all

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Photosynthesis in higher plants

lecture - 05

Botany

TARUN SIR

Topics

(Summary - Smart one shot)

1. Experiments

2. location of Photosynthesis
   type of pigments
   Light Reaction
   Chemiosmotic hypothesis

2. Dark Reaction
   photorespiration
   C-4 plants

1. Factors Affecting Photosynthesis

ISO → FEG

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Q7 If Radioactive Glucose tested For Radioactivity, Have H_1^3 then this come From ____ in higher plant

H_1^3 → Glucose – $C_6H_{12}O_6$

(a) CO_2 (b) H_2O (c) H_2S (d) Both b & c

Q8 Which is Oxygenic

(a) higher plant (b) Nostoc

(c) Euglenoids (d) all

(Protista - Diatom, Dino, Euglena)

Q9 Not occur on thylakoid

(a) Photolysis (b) Pigments (c) Sugar From (d) Chlorophyll Absorb light

$H_2O \rightarrow H + O \rightarrow O_2$

Glucose

Q10 Division of labour means in chloroplast

(a) Membrane system present (b) Chloroplast with stroma

(c) Stroma with Dark Rxn & thylakoid with light Rxn (d) None

Q11

S-I : Oxygenic Algae Cladophora use in T.W Engelman Experiment only 4]

S-II Van neil proved H_2O is only oxidizable Compound ✗

Q12 → S-I → In H_2O, if H is Radioactive appear in Glucose ✓

S-II → In H_2O, if O is Radioactive Appear in Oxygen ✓ Both correct molecule

Light Reaction

- About pigment ✓
- How pigment Function ✓
  - → Photosystem ✓
  - → Non cyclic ē Flow
    Cyclic ē Flow ✓
  - → Chemiosmotic hypothesis ✓

Wavelength	Absorb by ✓	PS I Active	PS II Active
(a) 450 nm	Antenna PS I, Antenna PS II	✓	✓
(b) 660 nm	Same	✓	✓
(c) 680 nm	Antenna of PS I, Rxn centre of PS II	✓	✓
(d) 681 nm	Antenna of PS I	✓	X
(e) 700 nm	Rxn centre of PS I	✓	X
(e) 701 nm	X	X	X

PS II - Active - Below or at 680 nm

PS I Active - Below or at 700 nm

Both Acting - Below 680 nm

PAR - 400 - 700 nm

Lowest Antenna

Rxn Centre of PS I

DOPA-02

Q1 Antennae present in all Except
(a) LHC (b) PS (c) Rxn centre (d) thylakoid

Q2 Sunlight can Excite ē of
(a) Antennae (b) Rxn centre (c) Both (d) none

Q3 Rxn centre - not true
(a) Work at lowest Energy (b) Always chla (c) work at highest wavelength (d) Pass Energy to Antennae

Q4 Carotene is
(a) Antennae in all Autotroph (b) Rxn centre in Algae (c) Antennae in Higher plant (d) not Absorb light

Q5 Green Algae & Red Algae have Similarity in
(a) Antennae (b) Rxn centre (c) Flagella (d) all

Q6 Which is not true — Chl a & Chl b

(a) PS II chlorophyll ✓ (b) Both Rxn centre ✓ (c) PS I Reaction centre is P^{700}

? Antennae

(c) PS II Rxn centre P^{680} (d) Chl b antennae in PS I not in PS II ✗

C - Y

Q7 Sunlight can Excite $\bar{e}$ in

(a) Antennae (b) Rxn centre (c) Both (d) none

Q8 Which is not correct Direction of Energy Among Pigments

(a) PS II to PS I (b) Antennae to P^{700nm} (c) Antennae to P^{680} (d) PS I to PS II

Q9 which work at lowest Energy

(a) P^{680} (b) P^{700} (c) Antennae of PS I (d) Antennae of PS II

Q10 Not Part of PS II

(a) P^{680} (b) Antennae at 640nm (c) Antennae at 680nm (d) $\bar{e}$ Acceptor

Q11 At wavelength 701 nm

(a) PS I Active (b) PS II Active (c) Both Active ~~(d) NO PS Active~~

Q12 At 630 nm _____ Absorb wavelength

(a) Antenna of PS I (b) Antenna of PS II (c) Rxn centre ~~(d) None~~ Both ✓ ✓6

PS I → 680

PS II → 700

of PS I

Q13 Three pigments → A = 400 B = 600 C = 450 D = 620

At wavelength 450 nm Direction 450 → 600 → 620

C B D

(a) B C D ~~(b)~~ (c) C B D (c) A C B D (d) None

Q14 Enzymes are associated with

~~(a)~~ Rxn centre (b) Antenna (c) Both (d) None

Q15 LHC involve → ~~(a)~~ Antenna (b) Chl b (c) Carotene ~~(d)~~ all

last Class Revision

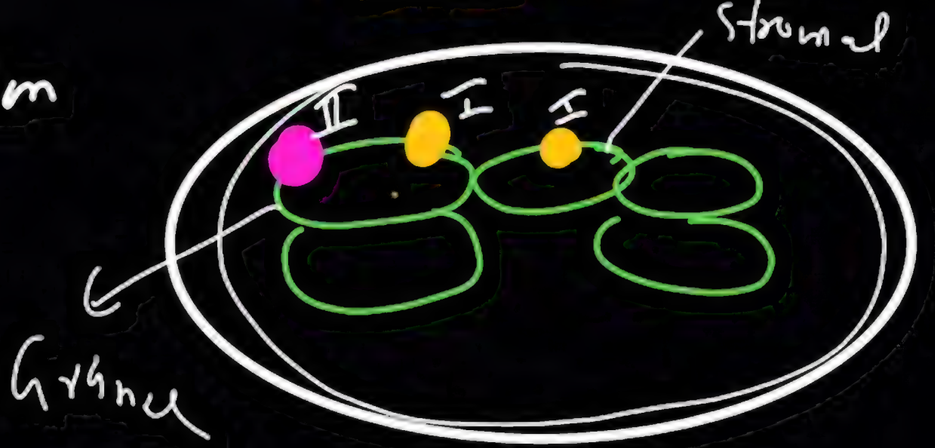
→ Pigments → chemical compound

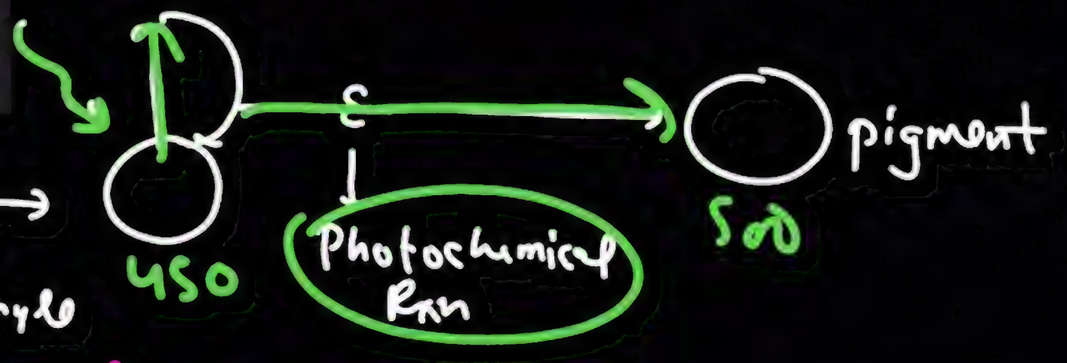
→ Type – chla, chlb, carotenoids, Xanthophylls

→ on the Basis of Function
- Rxn centre – chla
- Antennae – chlb, Carotenoids, Xanthophylls } LHC

→ Photosystem
- Pigments
  - Rxn centre ✓
  - Antennae ✓
- e⁻ carrier
- Enzyme

→ location





PS II ✓	PS I ✓
Discovery – Second	First
Rxn centre chla P^{680}	chla P^{700}
Granal thylakoid	Granal + Stromal lamellae

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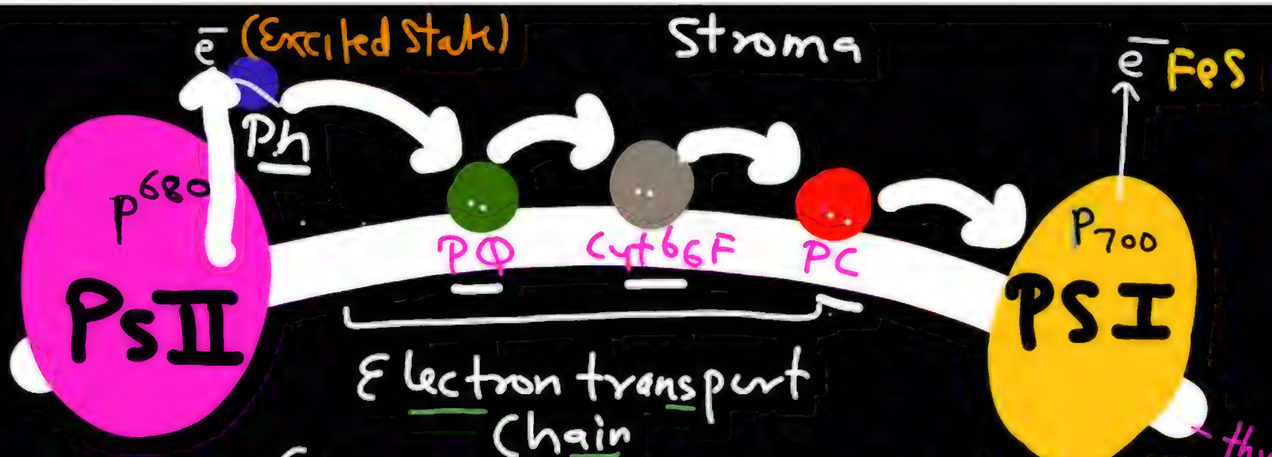
Electron Flow through photosystem



- Light → less than 680 nm (Both PS Active)
- Photosystem exite - Both
- Primary Acceptor of Photosystem → PS II - Phaeophytin, PS I → Fes
- e⁻ Carrier B/w PS II & PS I
  - Phaeophytin
  - Plasto Quinone
  - Cytochrome b6F
  - Plastocyanin

- Ph - Phaeophytin - Primary e⁻ Acceptor of PS II → P
- PQ - Plasto Quinone → Q
- Cytb6F → Cytochrome b6F → C
- PC → Plastocyanin → P

Electron Flow through photosystem

Primary Acceptors of PS I → FeS → FeS pass ē to Fd - Ferrodoxin

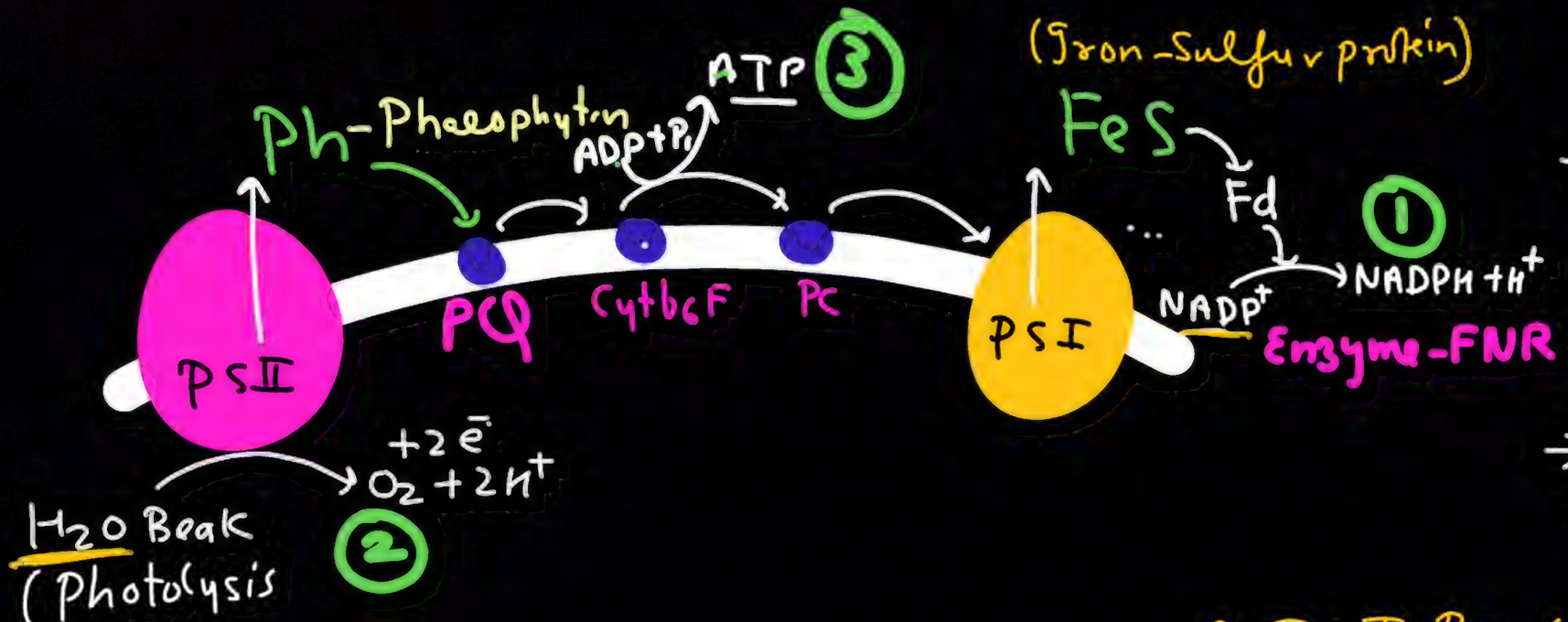
→ PS II to ē move to PS I - through ETC (Electron transport Chain

→ PS I → ē → Fes → Fd → NADP+ → NADPH

Enzyme - FNR - Ferrodoxin NADP Reductase

→ $NADP + \bar{e} + H^+ \xrightarrow{Red} NADPH$

→ $NADP^+ + 2\bar{e} + 2H^+ \longrightarrow NADPH + H^+$



→ PS I - take e⁻ From PS II when it is e⁻ deficient

→ PS II Break (oxidise) Water & take e⁻

Q PS II Break water

(I) PS II is in oxidised (e⁻ deficient)

(II) PS II is in Reduced (e⁻ present)

Steps In $\bar{e}$ Flow — Product → NADPH, ATP, O_2

(a) Wavelength excite $\bar{e}$ in Both Photosystem together - less than 680

(b) Both PS Excited together →

(c) Primary Acceptor of PS II is Pheophytin and of PS I is Fes

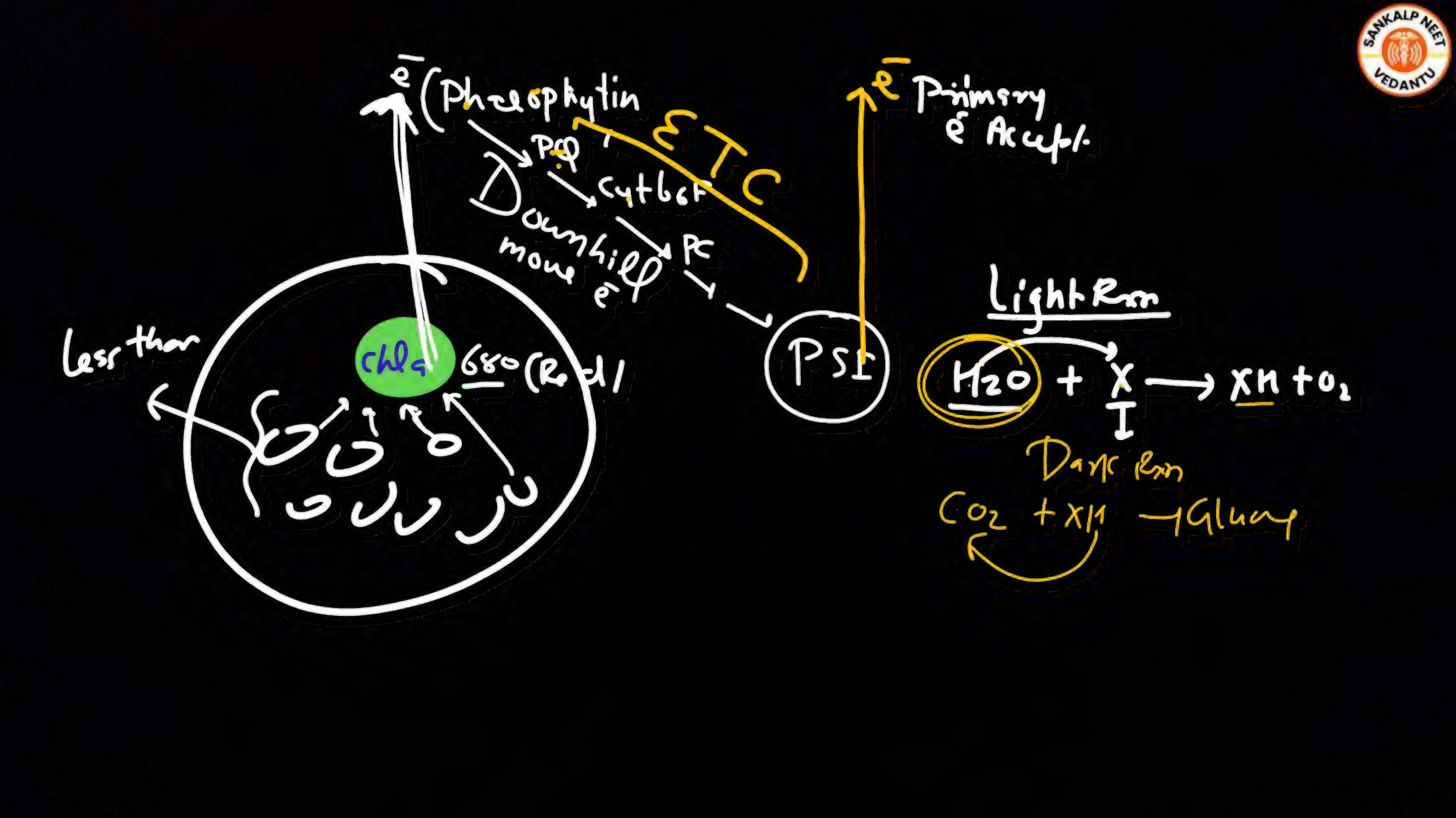
(d) $\bar{e}$ Flow From pheophytin to PS I through ETC (Electron transport chain) Downhill move

(e) $\bar{e}$ From PS II is move to PSI through - ETC & ATP synthesis occur

(f) $\bar{e}$ of PS I → Fes → Fd → and Finally Reduce $NADP^+$ in NADPH (Enzyme - Ferredoxin NADP Reductase (FNR))

(g) $\bar{e}$ from PS I move to $NADP^+$ & From PS II to PSI (Due to which PS II $\bar{e}$ deficient)

(i) PS II Break (oxidise) water When PS II is $\bar{e}$ deficient


e⁻ (Pheophytin
PSII
Cytb6f
PC
Downhill movement e⁻
ETC
e⁻ Primary e⁻ Acceptor
Less than
Chla
680 (Red)
PSI
Light Rxn
H2O + X → XH + O2
Dark Rxn
CO2 + XH → Glucose

$NADP + H^+ + e^- \longrightarrow NADPH$

$NADP^+ + 2e^- + 2H^+ \rightarrow NADPH + H^+$

(e^- deficient) X

photolysis

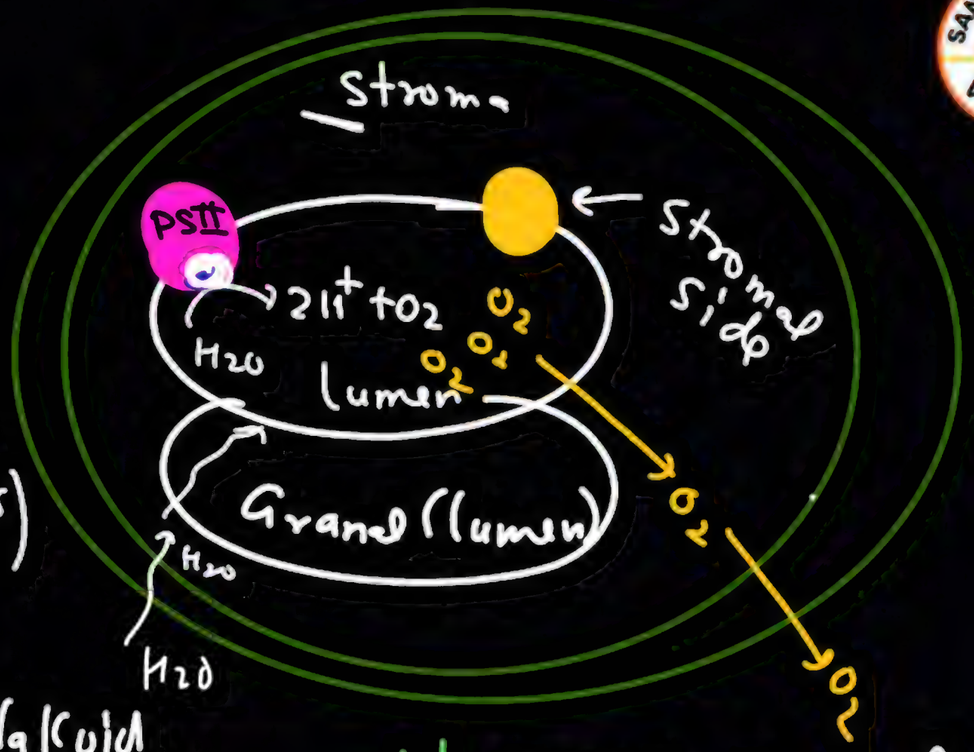
→ Breakdown of water → By PS II

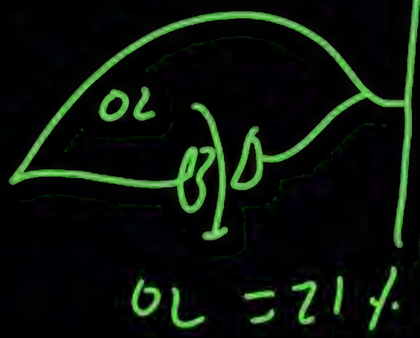
→ PS II → luminal side (thylakoid) → Enzyme For Breakdown of Water

(Mn^{+2}, Cl^- → help in photolysis)

→ Due to which O_2 Form inside → lumen of Granal thylakoid

→ H^+ also Form inside lumen





Q Highest conc. of O_2 is

(a) Stroma of chloroplast

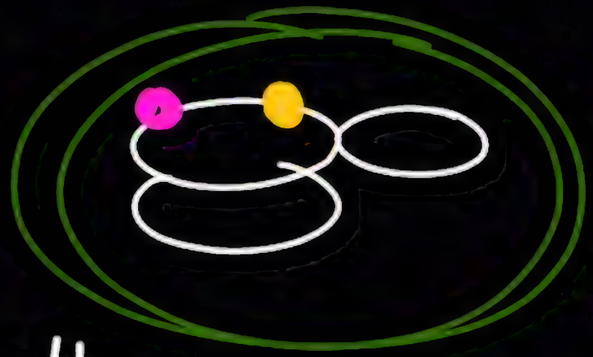
(b) lumen of thylakoid ✓

(c) Inside leaf

(d) Outside leaf

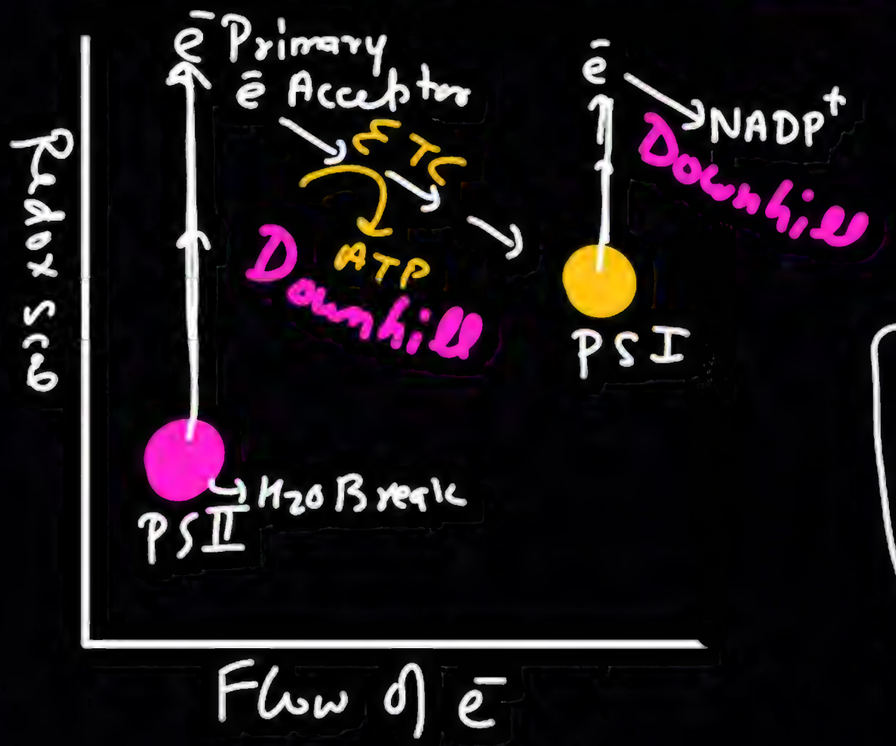
Z-scheme

- If we Draw PS II & PS I → on Redox scale

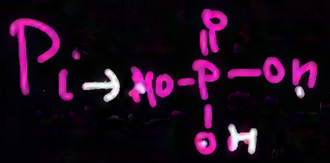


Real

→ Z-shape appear (Z-Scheme)



→ Both PS I & PS II e⁻ Exite → Accepted By Primary e⁻ Acceptor → e⁻ move Downhill



Cyclic and noncyclic Flow of e

→ ATP synthesis → Biological system → ADP is phosphorylate (phosphate add) to make ATP

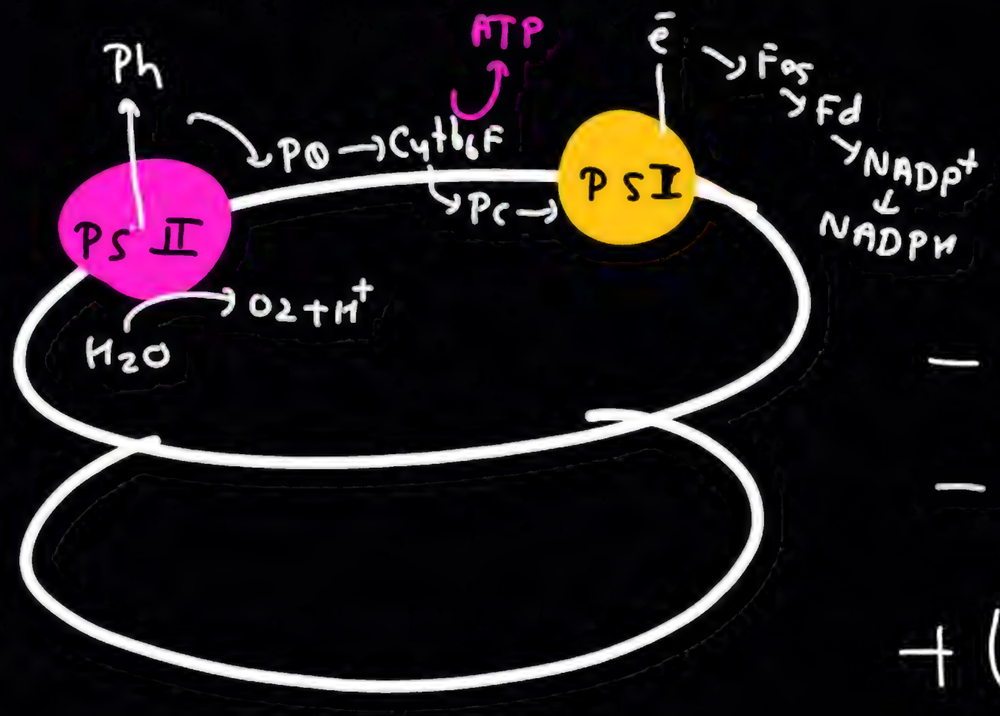
ADP + Pi ⟶ ATP Form (Phosphorylation)

→ In light Rxn, ATP form B/w PS II & PS I (with the energy of e⁻)

ē Excited By → light → Such ATP synthesis → Photo Phosphorylation

Light ATP Synthesis

Non-cyclic Flow of $\bar{e}$



This is non-cyclic Flow of $\bar{e}$

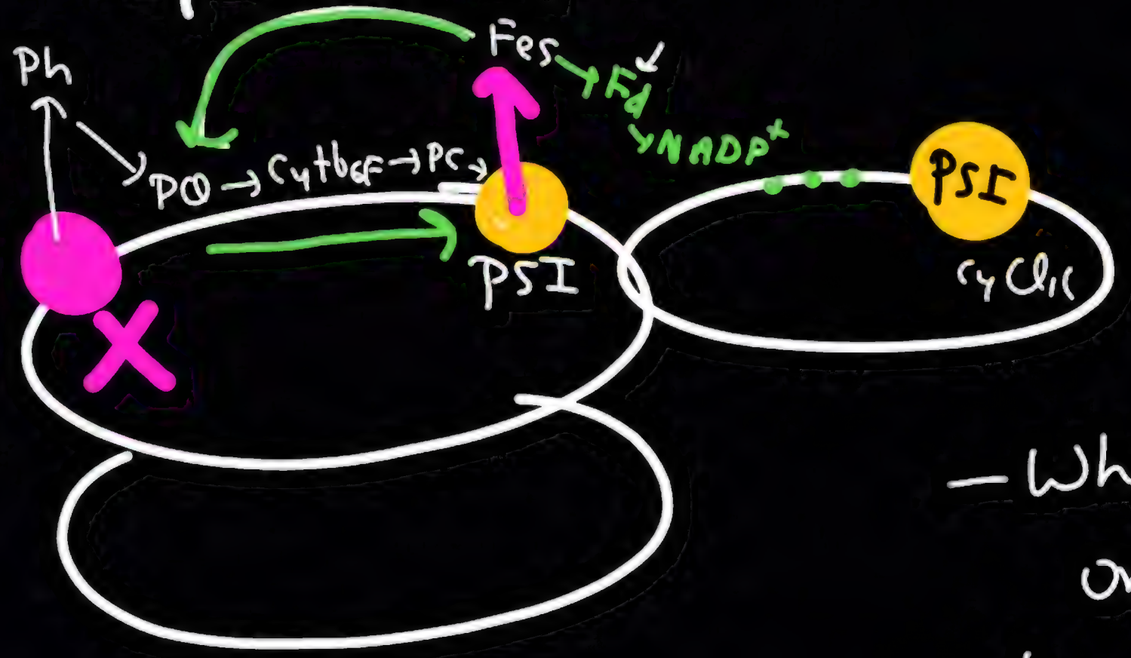
– $\bar{e}$ of PS II & PS I not come back

– Product → O_2, ATP, NADPH

– Granal thylakoid → PS II & PS I
Both involve

+ light less than 680 nm

Cyclic Flow of e^-



— When only PS I is Active

Condition → on Granal thylakoid

Light more than 680 nm

— Stromal only PS I present

} only PS I Active

— When light More than 680 nm

only PS I Active → Fes give e^-

to PQ → $Cytb_6F$ → PC → PS I

→ ATP synthesis

→ O_2 not Frorr

→ NADPH not Frorr

Q FNR Enzyme present

~~(a)~~ Granal thylakoid

(b) Stromal lamella

(c) Both

(d) Stroma

Non cyclic Flow of e^-

Location – Granal thylakoid

Condition → less than 680nm

PS Active → PS I & PS II

→ H_2O Break – Photolysis occur

NADPH Form

ATP Form

PS II → Ph → PQ → Cyt b_6f → PC → PS I

P Q C P

Cyclic Flow of e^-

Location → Granal, Stroma (Always)

↓

More than 680nm

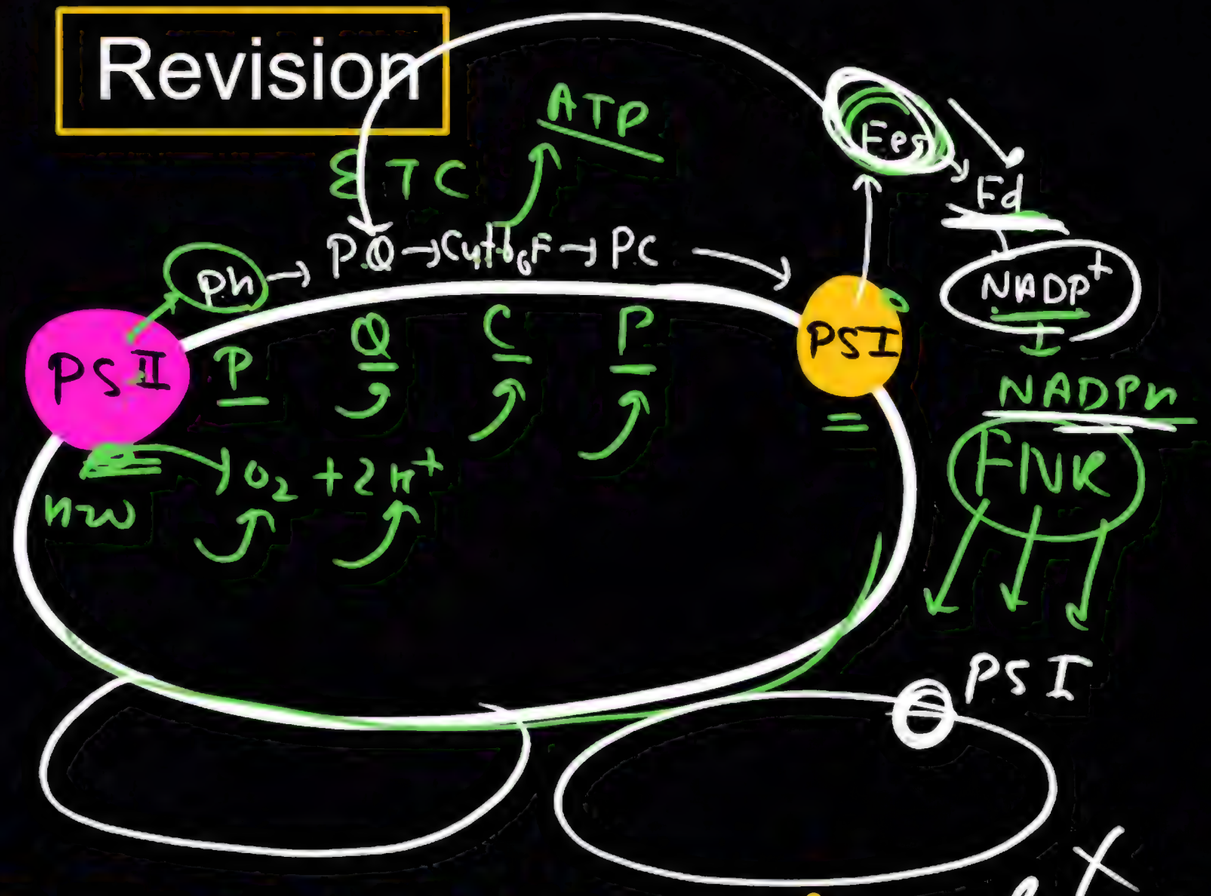
PS Active → only PS I

→ only ATP Form → No photolysis

PS I → Fes → PQ → Cyt b_6f → PC → PS I

F Q C P

Revision



Q ē carrier Absent in stromal lamella (PS I)

a) Fes (b) Ph (c) PQ

(d) Cyt b6f

FNR ✗
NADPH ✗
H2O, O2 ✗

* light - less than 680 nm
* Grana
* PEA →
* ETC →

Ph

PQ, Cyt b6f, PC

* Non-cyclic Flow → ATP, NADPH, O2
* Cyclic Flow → ATP, Stromal lamella, More than 680
* Photolysis

DOPA-03

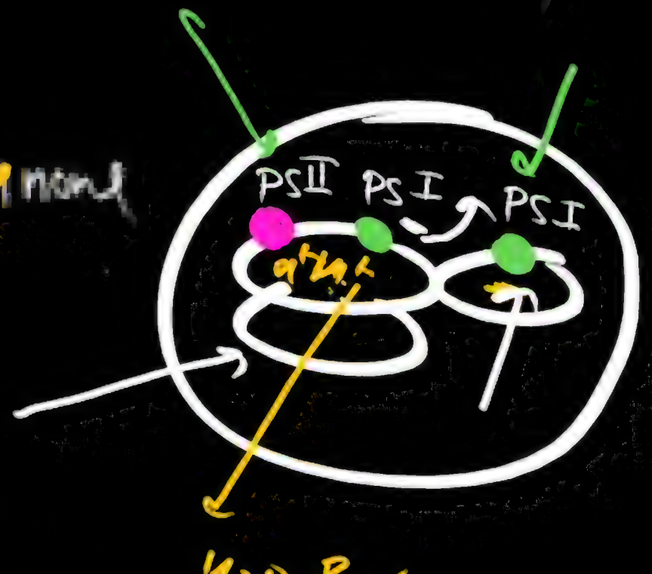
Q1 PS I & PS II Both Active
(a) More than 680 (b) Stromal lamellae (c) Cyclic Flow of $\bar{e}$ (d) none

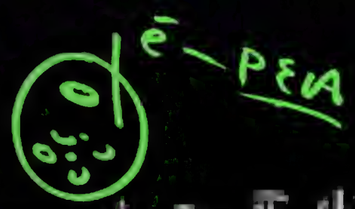
Q2 Cyclic Flow of $\bar{e}$ not involved
(a) PS I (b) ETC (c) Pheophytin (d) In TP Synthesis

Q3 At 660 nm on Stromal lamellae (PS I)
(a) Cyclic Flow of $\bar{e}$ (b) FNR Active (c) Pheophytin Active (d) all

Q4 Non Cyclic Flow of $\bar{e}$ not involved
(a) Low PH in granal thylakoid (b) Oxygen Evolution (c) Mn & Ca^{2+} (d) Low PH in Stromal lamellae

Q5 PS II involve in photolysis in
(a) Reduced state (b) Oxidised State (c) Both (d) non





Q6 Which occur last
(a) Excitation of Antennae in PS II (b) e⁻ Excite in Rxn centre (c) PS II Oxidized (d) Photolysis

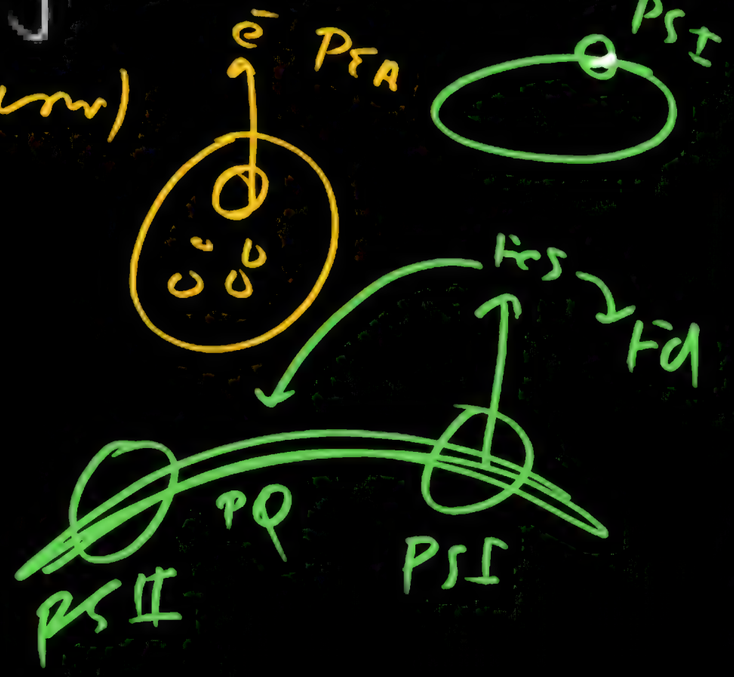
Q7 Highest conc of Oxygen in
(a) Lumen of thylakoid (b) Stroma (c) inside leaf (d) outer Environment

Q8 For Reduction of NADP which not Require (NADPH Form)
(a) PS II (b) More than 680 (c) FNR (d) PS I
(Only PS I)

Q9 NADP is Reduce By
(a) FNR (b) Fd (c) PS II (c) Pheophytin

Q10 In cyclic Flow, Fe₂ Reduce
(a) PS II (b) PQ (c) Fd (d) NADP

Q11 Stromal lamellae not have
(a) PS II (b) FNR (c) Reduction of NADP (d) all



Chemiosmotic hypothesis — Peter Mitchell

What it Explain → ATP synthesis occur in Both Cyclic & non-cyclic Flow of e^- on thylakoid Membrane → Photophosphorylation

→ How ATP Synthesis occur in chloroplast

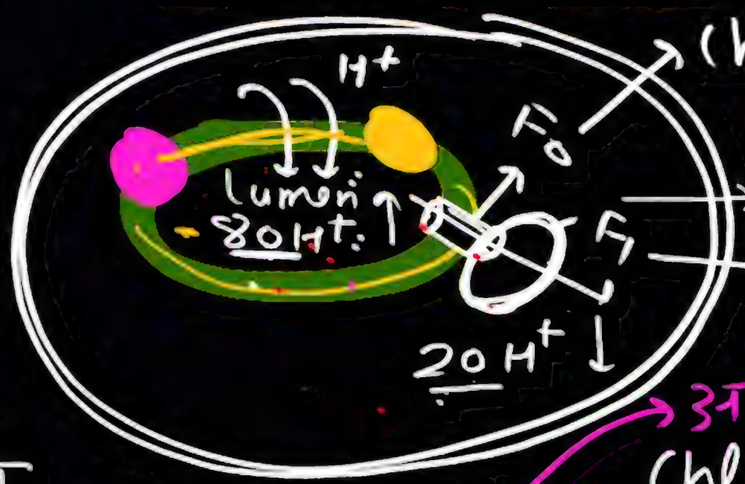
⇒ Valid For Both chloroplast & Mitochondria

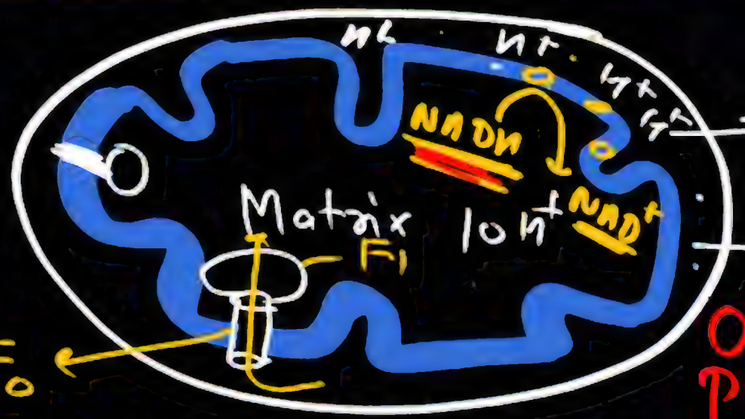
For ATP synthesis → Four conditions Require

(a) Proton Gradient
(b) Intact Membrane
(c) Proton pump
(d) F_o-F_1 particle / ATP Synthase

Four Requirement to make ATP

— valid For Both Mitochondria & chloroplast





I → Proton Gradient → अंतर (Chloroplast – more proton thylakoid lumen; Mitochondria → Intermembrane Space → H^+ More)

II Intact Membrane — not Allow leakage of Proton

III **Proton pump** — Somehow proton pump (Stroma to thylakoid lumen)

(IV) FO – F_1 (Mitochondria – Inner Membrane ✓
(FO – (F_1 → (Chloroplast → thylakoid Membrane] — Fo – Channel (Proton
F_1 → Head (Rotate) (Channel

How Proton Gradient Form in chloroplast stroma & lumen

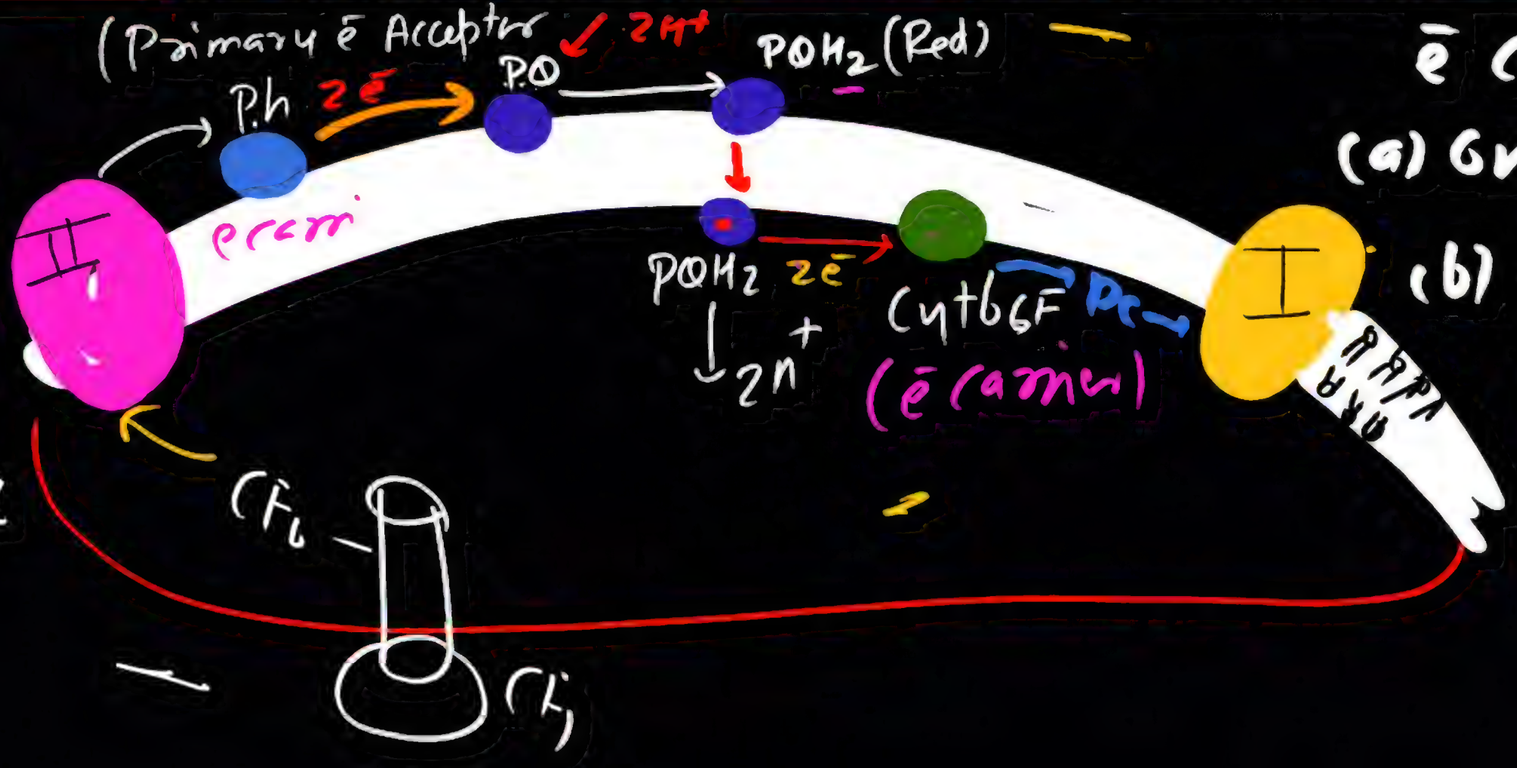
Three method

(a) Photolysis By PS II → occur at luminal side – Produce Proton in lumen (granal thylakoid)

(b) FNR Enzyme located at stromal side which help to synthesis NADPH which use proton – From Stroma

(c) $\bar{e}$ move From PS II to PS I through $\bar{e}$ carrier → that Energy is Use to pump proton → From Stroma to lumen

(b) As electrons move through the photosystems protons are transported across the membrane. This happens because the primary accepter of electron which is located towards the outer side of the membrane transfers its electron not to an electron carrier but to an H carrier. Hence, this molecule removes a proton from the stroma while transporting an electron. When this molecule passes on its electron to the electron carrier on the inner side of the membrane, the proton is released into the inner side or the lumen side of the membrane.

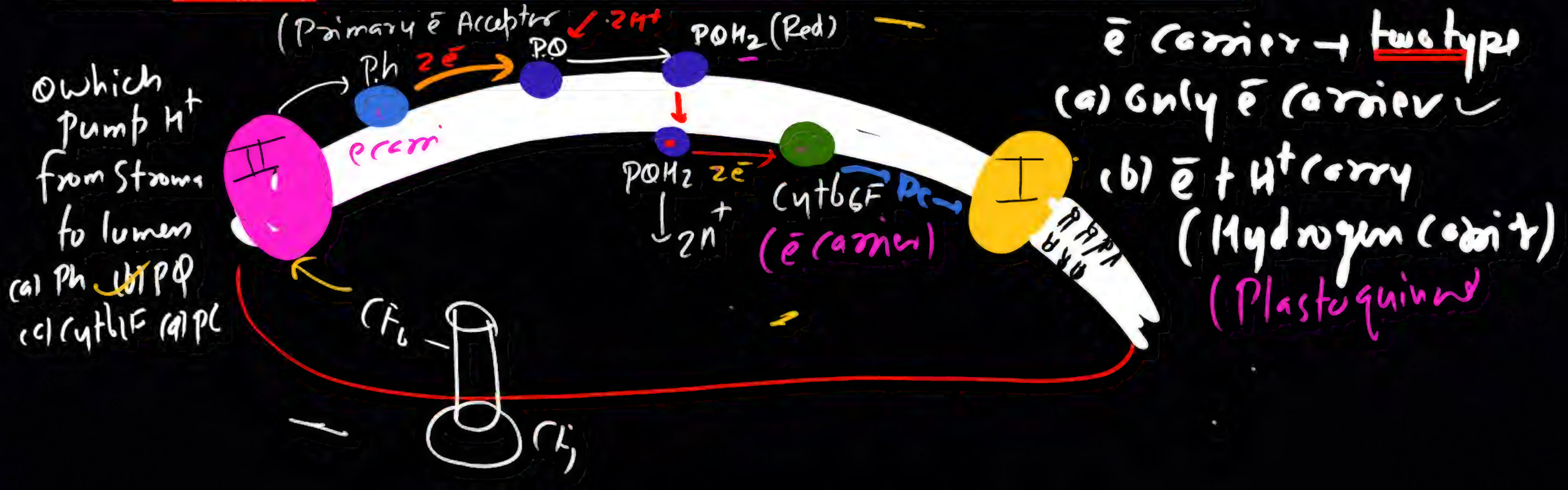


Which pump H+ from Stroma to lumen
(a) Ph (b) PQ
(c) Cyt b1F (d) PC

ē carrier → two types
(a) Only ē carrier
(b) ē + H+ carry (Hydrogen carrier)
(Plastoquinone)

(b) As electrons move through the photosystems protons are transported across the membrane. This happens because the primary accepter of electron which is located towards the outer side of the membrane transfers its electron not to an electron carrier but to an H carrier. Hence, this molecule removes a proton from the stroma while transporting an electron. When this molecule passes on its electron to the electron carrier on the inner side of the membrane, the proton is released into the inner side or the lumen side of the membrane.

$PQ + 2H^+ + 2e^- \rightarrow PQH_2$



Which pump H^+ from Stroma to lumen
(a) Ph (b) PQ
(c) Cytb6F (d) PC

ē carrier → two type
(a) Only ē carrier
(b) ē + H^+ carry (Hydrogen carrier)
(Plastoquinone)

ATPSynthesis ocur

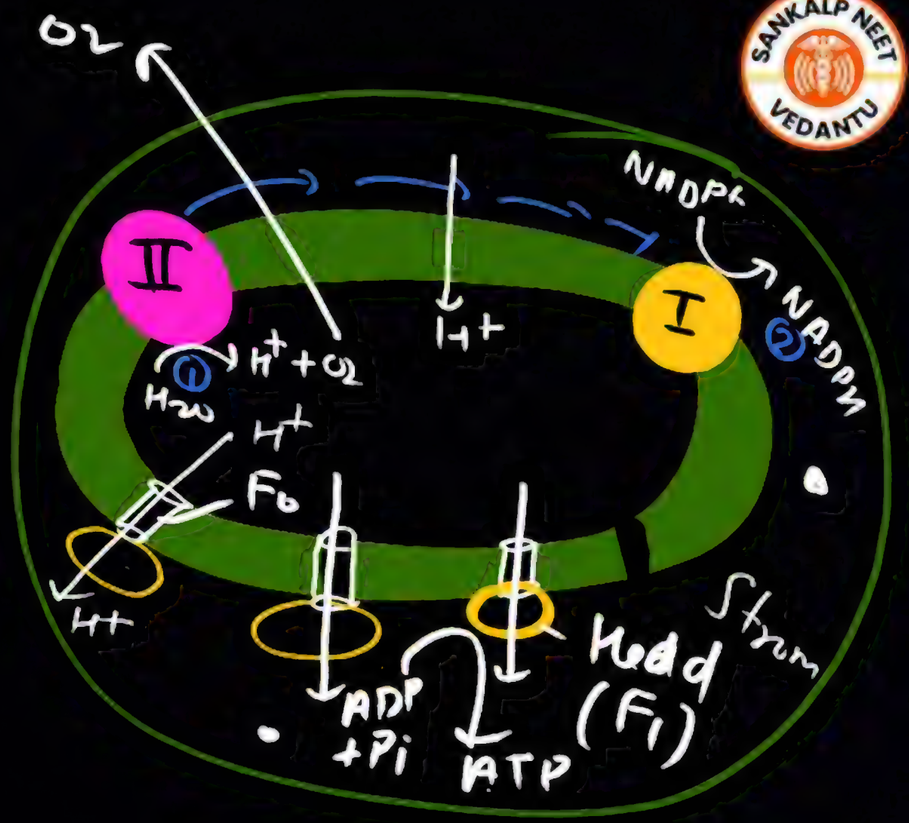
- Why this proton Gradient is Important
- Proton Gradient help to - Synthesise ATP

→ thylaloid Membrane, Fo-Fi ((Fo-(Fi) Present (chloroplast)

⟶ Fo - channel - proton channel — Integral poulein

⟶ Fi - head - Conformational (Peripheral) Change occur when protons move from thylaloid lumen to Struma

Fo - Fi = ATP Synthase



Let us understand what causes the proton gradient across the membrane. We need to consider again the processes that take place during the activation of electrons and their transport to determine the steps that cause a proton gradient to develop (Figure 11.7).

(a) Since splitting of the water molecule takes place on the inner side of the membrane, the protons or hydrogen ions that are produced by the splitting of water accumulate within the lumen of the thylakoids.

(b) As electrons move through the photosystems, protons are transported across the membrane. This happens because the primary accepter of electron which is located towards the outer side of the membrane transfers its electron not to an electron carrier but to an H carrier. Hence, this molecule removes a proton from the stroma while transporting an electron. When this molecule passes on its electron to the electron carrier on the inner side of the membrane, the proton is released into the inner side or the lumen side of the membrane.

FNR PS II $NADP^+ + e^- + H^+$

(c) The NADP reductase enzyme is located on the stroma side of the membrane. Along with electrons that come from the acceptor of electrons of PS I, protons are necessary for the reduction of $NADP^+$ to $NADPH + H^+$. These protons are also removed from the stroma.

Dopa-04

Q1 PS II not have part
(a) chl a (b) chl b (c) Pheophytin (d) Plastoquinone

Q2 Cyclic and non-cyclic Flow of $\bar{e}$ have common
(a) FNR (b) PQ (c) Pheophytin (d) Reduction of NADP

Q3 H^+ Gradient to make ATP present in
(a) Chloroplast (b) Mitochondria (c) ER (d) Both a & b

Q4 High conc. of H^+ is present in chloroplast
(a) Stromal lamellae (b) Stroma (c) Granal thylakoid (d) Both a & c

Q5 High conc. of H^+ is present in Mitochondria
(a) Matrix (b) intermembrane space (c) Inner membrane (d) Outer membrane

Q6 By Method :— Proton Gradient produce in Granal thylakoid & Stroma
(a) Photolysis (b) Reduction of $NADP^+$ (c) Hydrogen carrier B/w PS II & PS I (d) all

Q7 By Method proton Gradient produce in Stromal lamella & Stroma
(a) Photolysis (b) Reduction of $NADP^+$ (c) Hydrogen carrier (d) all

Q8 In B/w PS II & PS I, Hydrogen carrier is
(a) Cyt b_6F (b) PQ (c) Plastocyanin (d) all

Q9 Which is located Outer side of thylakoid Membrane
(a) Pheophytin (b) Cyt b_6F (c) PQ (d) Both a & b

Q10 Hydrogen carrier B/w PS II & PS I give $\bar{e}$ to ____ in ____ side of thylakoid Membrane
(a) Plastocyanin, outer (b) Cyt b_6F outer (c) Cyt b_6F inner (d) all

MANTHAN NEET 2025 - 1.0 & 2.0

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Photosynthesis in higher plants

lecture - 06

Botany

TARUN SIR

Topics

(Summary – Smart one Shot)

1 [Experiments]

2 [
- location of Photosynthesis
- type of pigments
- Light Reaction
- Chemiosmotic hypothesis
]

2 [Dark Reaction
photorespiration]

C-4 plants

1 [Factors Affecting Photosynthesis]

[ISO → FEG]

3-4 Q (conceptual Question)

List of Experiments

1 (a) Variegated Leaf
2 (b) KOH - half leaf
Result - Green Area - Photosynthesis occur in presence of light

CO_2 is Important For Photosynthesis

3 (c) Bell Jar (Priestley) (1770) Experiment
Mice & candle - Damage Air Quality
Mint plant - Restore Air Quality (O_2 produce)

4 (d) Ingenhousz
→ Light is Important
→ High light intensity can produce O_2 Bubble

5 (e) Von Sach (1854)
Plant Grow → In Green Area - Glucose Form store in Form of Starch

(f) T.W Engleman
→ Light split → Spectral component → Blue & Red wavelength - More photosynthesis
First Action spectrum Form → Similar to Absorption spectrum of Chla & Chlb

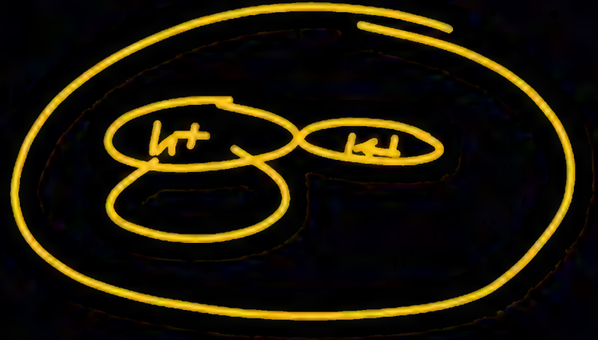
(g) Van neil
→ O_2 produce in photosynthesis come From H_2O
→ H_2S is Donor of Hydrogen
→ Equation Corrected For photosynthesis ($6CO_2 + 12H_2O \rightarrow C_6H_{12}O_6 + 6O_2$)
→ Verified By - Radio isotope technique

Dopa-04

Q1 PS II not have part
(a) Chl a (b) Chl b (c) Pheophytin (d) Plastoquinone

Q2 Cyclic and non-cyclic Flow of $\bar{e}$ have common
(a) FNR (NC) (b) PQ (C & NL) (c) Pheophytin (NC) (d) Reduction of NADP (NC)

Q3 H^+ Gradient to make ATP present in
(a) Chloroplast (b) Mitochondria (c) ER (d) Both a & b



Q4 High conc. of H^+ is present in chloroplast
(a) Stromal lamellae (b) Stroma (c) Granal thylakoid (d) Both a & c

Q5 High conc. of H^+ is present in Mitochondria
(a) Matrix (b) intermembrane space (c) Inner membrane (d) Outer membrane

Q6 By Method :- Proton Gradient produce in Granal thylakoid & Stroma

(a) Photolysis (b) Reduction of $NADP^+$ (c) Hydrogen carrier (d) all

Q7 By Method proton Gradient produce in Stromal lamella & Stroma

(a) Photolysis (b) Reduction of $NADP^+$ (c) Hydrogen carrier (d) all

Q8 In B/w PS II & PS I, Hydrogen carrier is

(a) Cyt b_6F (b) PQ (c) Plastocyanin (d) all

Q9 Which is located Outer side of thylakoid Membrane

(a) Phaeophytin (b) Cyt b_6F (c) PC (d) Both a & c

Q10 Hydrogen carrier B/w PS II & PS I give $\bar{e}$ to ____ in ____ side of thylakoid Membrane

(a) Plastocyanin, outer (b) Cyt b_6F outer (c) Cyt b_6F inner (d) all

Dark Reaction

Steps in photosynthesis

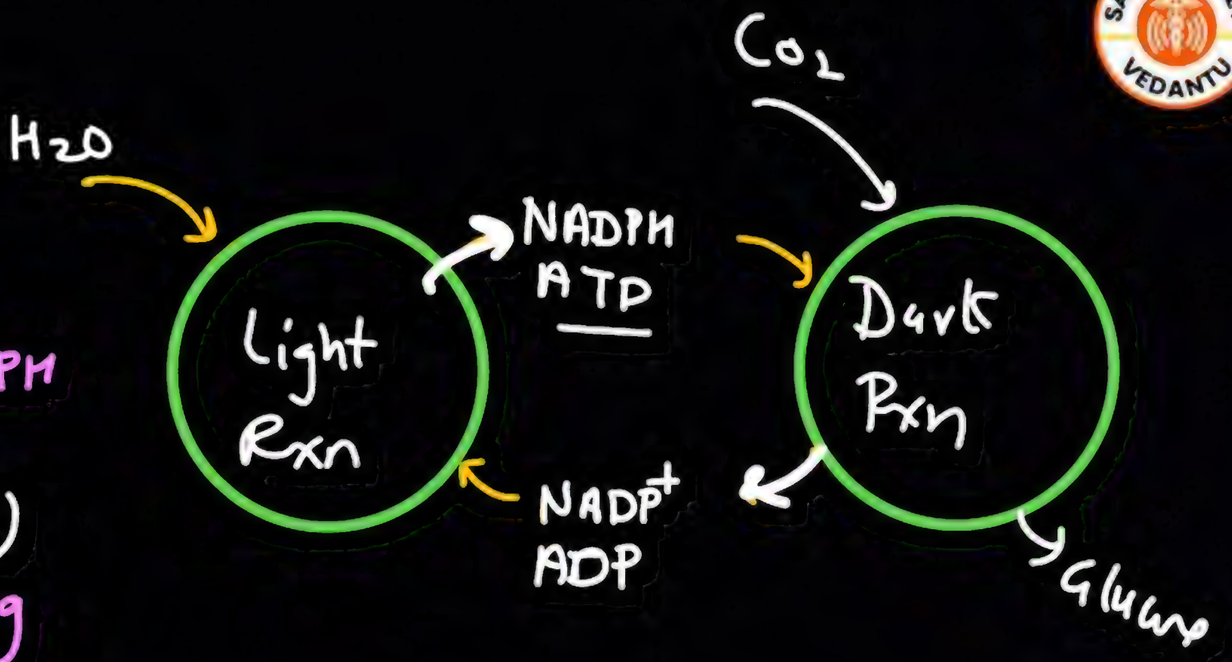
Light Rxn → (Photochemical Phase) — on thylakoid Membrane

$H_2O + NADP^+ \rightarrow O_2 + NADPH$

ADP + Pi → ATP

O_2 – By Product (not use)

ATP, NADPH – High Energ Intermediate (Use in Dark Rxn)



Dark Rxn – Biosynthetic Phase (Reduction of CO_2) to form Glucose

$CO_2 \xrightarrow[\text{Use ATP, NADPH}]{\text{Reduction}} \text{Glucose}$

Important points

1. Dark Reaction is misnomer → Wrong name → because it not occur in Dark, depend on product of Light Rxn
2. Dark Reaction start after Light Reaction — In morning — Light Rxn Start After then Dark Rxn start (Evening - Light Rxn stop & then Dark Rxn)
3. Product of Dark Reaction → Sugar - Glucose
4. Intermediate use in Dark Reaction → NADPH, ATP

Q Dark Rxn Favored By
(a) low ATP ✗
(b) High NADPH ✓
(c) High Sugar → ✗
(d) all

Q S-I In morning Light & Dark Rxn start together ✗
S-II In Evening when all NADPH & ATP ✓ Consume, Dark Rxn Stop

Q In night, present in Chloroplast
(a) O_2 produce (b) ATP, NADPH (c) Sugar (d) all

11.7 Where are the ATP and NADPH Used?

We learnt that the products of light reaction are ATP, NADPH and O_2. Of these O_2 diffuses out of the chloroplast while ATP and NADPH are used to drive the processes leading to the synthesis of food, more accurately, sugars. This is the **biosynthetic phase** of photosynthesis. This process does not directly depend on the presence of light but is dependent on the products of the light reaction, i.e., ATP and NADPH besides CO_2 and H_2O. You may wonder how this could be verified; it is simple: immediately after light becomes unavailable the biosynthetic process continues for some time, and then stops. If then, light is made available, the synthesis starts again.

Can we, hence, say that calling the biosynthetic phase as the ***dark reaction****, is a misnomer? Discuss this amongst yourselves.*

Discovery of Dark Reaction

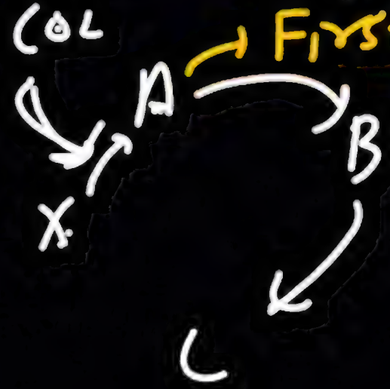
– Calvin use – Radioactivity – For positive use

– Location of Dark Rxn – Stroma

– Scientist → Calvin → Use – C^{14} – Radioactive Isotope of Carbon

– Method use → Radioactive tracer technique

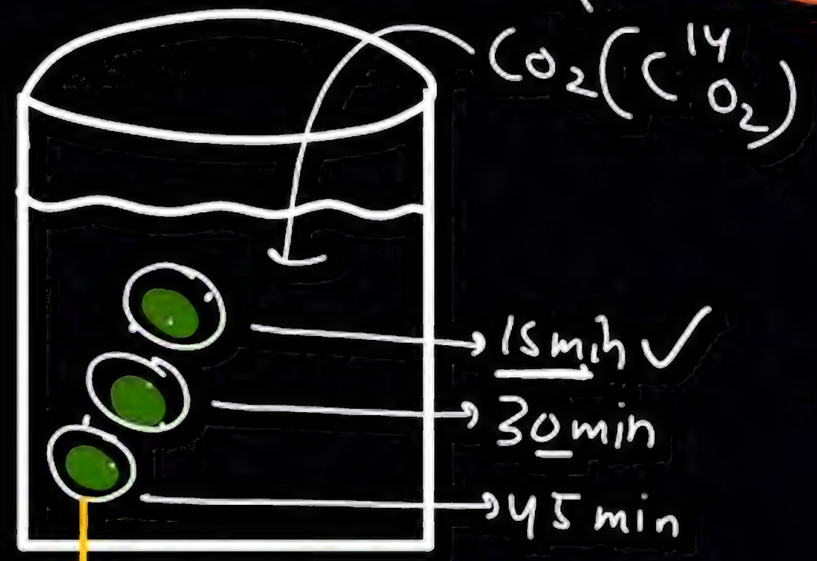
Algae is provided with $CO_2(C^{14})$ and product in chloroplast test at Different time



Findings:-

(a) First product of CO_2 Fixation – PGA (Phosphoglyceric Acid)

(b) Complete steps Find out of Dark Rx2

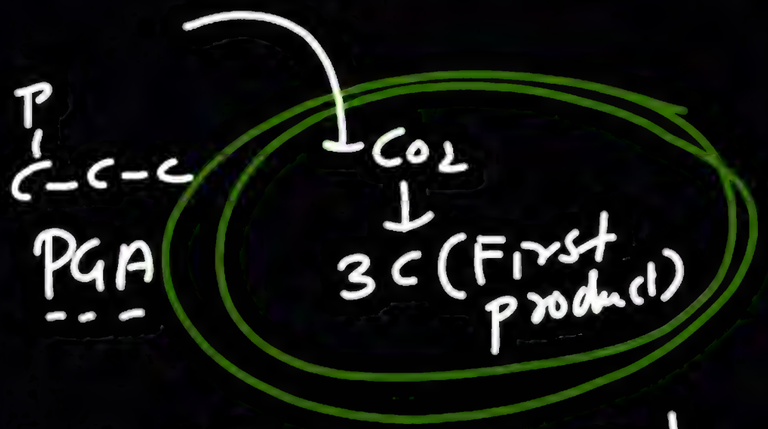


– CO_2 (Radioactive provide) → test Algae For Radioactivity at Different time

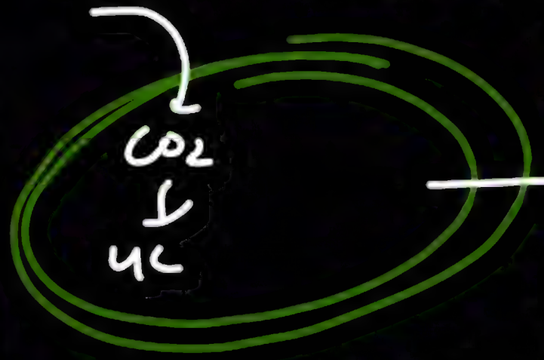
Let us now see how the ATP and NADPH are used in the biosynthetic phase. We saw earlier that CO_2 is combined with H_2O to produce $(CH_2O)_n$ of sugars. It was of interest to scientists to find out how this reaction proceeded, or rather what was the first product formed when CO_2 is taken into a reaction or fixed. Just after world war II, among the several efforts to put radioisotopes to beneficial use, the work of Melvin Calvin is exemplary. The use of radioactive ^{14}C by him in algal photosynthesis studies led to the discovery that the first CO_2 fixation product was a 3-carbon organic acid. He also contributed to working out the complete biosynthetic pathway hence it was called **Calvin cycle** after him. The first product identified was **3-phosphoglyceric** acid or in short **PGA**. *How many carbon atoms does it have?*

First product in carbon dioxide Fixation

- In most plants → First CO_2 Fixation product – is PGA → 3C
- In some plants → First CO_2 Fixation product is of 4-C → OAA (oxalo acetic Acid) (4C)



(C-3 pathway)
(most plant)



→ C-4 pathway present in C-4 plants

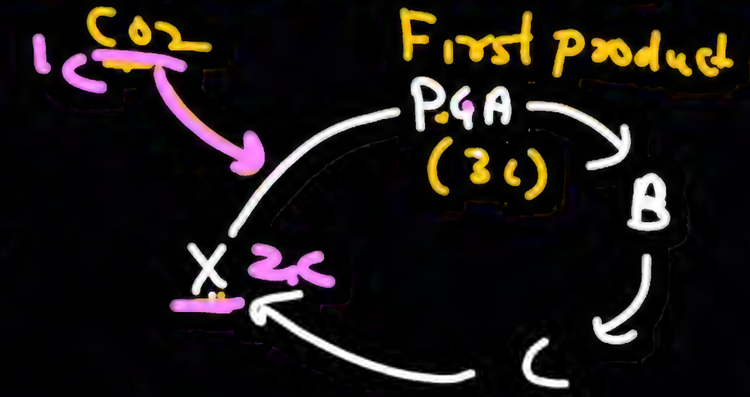
Ex- Sugarcane, Maize, Sorghum (tropical Condition)

note - Wheat & Rice Are monocot not C-4

Scientists also tried to know whether all plants have PGA as the first product of CO_2 fixation, or whether any other product was formed in other plants. Experiments conducted over a wide range of plants led to the discovery of another group of plants, where the first stable product of CO_2 fixation was again an organic acid, but one which had 4 carbon atoms in it. This acid was identified to be **oxaloacetic acid** or OAA. Since then CO_2 assimilation during photosynthesis was said to be of two main types: those plants in which the first product of CO_2 fixation is a C_3 acid (PGA), i.e., the **C_3 pathway,** and those in which the first product was a C_4 acid (OAA), i.e., the **C_4 pathway**. These two groups of plants showed other associated characteristics that we will discuss later.

Primary Carbon dioxide Acceptor

→ Calvin → First product – 3C (organic Acid)

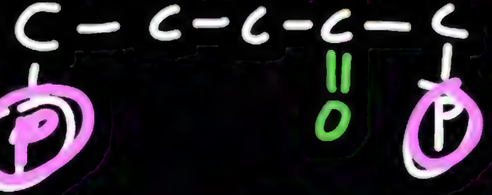


→ X – Primary acceptor + CO_2 ⟶ PGA Form

→ For many Scientist try to Find 2C Compound to which CO_2 combine to Form PGA (3C)

– In Reality → RUBP (5C) – Sugar → Ribulose 1,5 bis phosphate

(Ketose Sugar)



RUBP + CO_2 ⟶ PGA (3C) X2 molecule

(5C)

Primary CO_2 Acceptor = 5C → RUBP (Sugar)

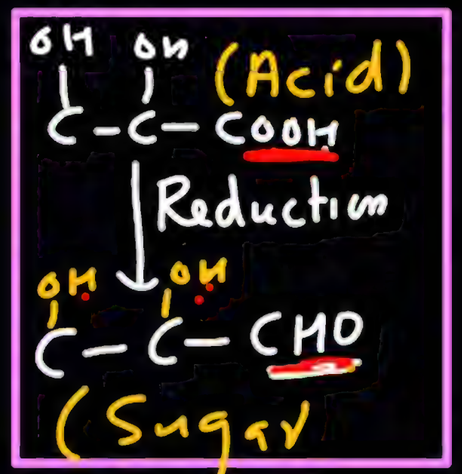
11.7.1 The Primary Acceptor of CO_2

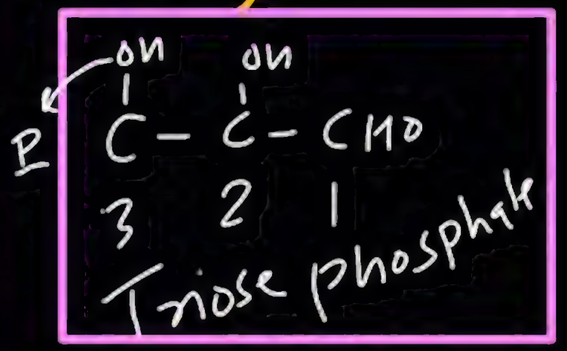
Let us now ask ourselves a question that was asked by the scientists who were struggling to understand the 'dark reaction'. *How many carbon atoms would a molecule have which after accepting (fixing) CO_2, would have 3 carbons (of PGA)?*

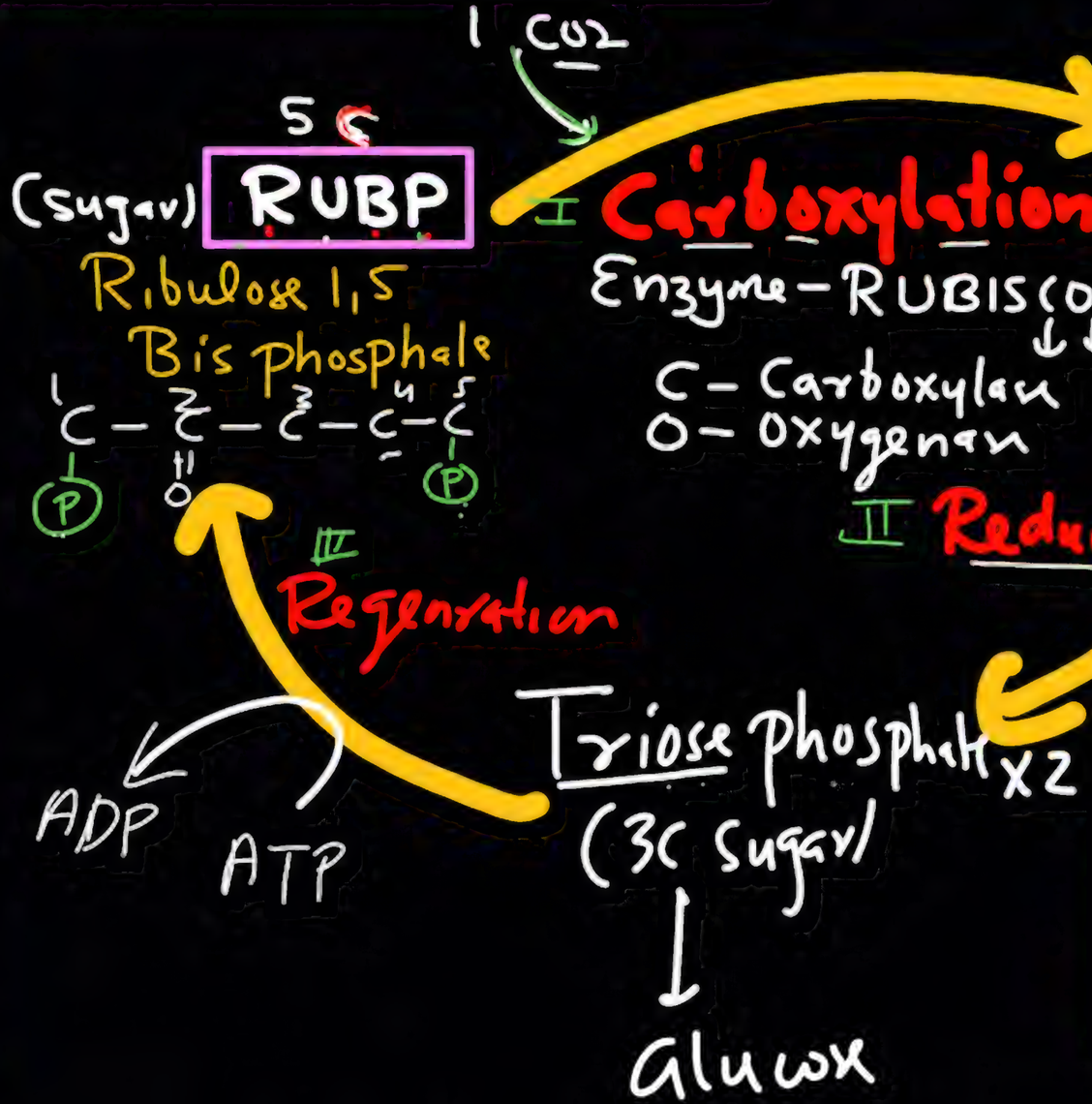
The studies very unexpectedly showed that the acceptor molecule was a 5-carbon ketose sugar – ribulose bisphosphate (RuBP). *Did any of you think of this possibility?* Do not worry; the scientists also took a long time and conducted many experiments to reach this conclusion. They also believed that since the first product was a C_3 acid, the primary acceptor would be a 2-carbon compound; they spent many years trying to identify a 2-carbon compound before they discovered the 5-carbon RuBP.

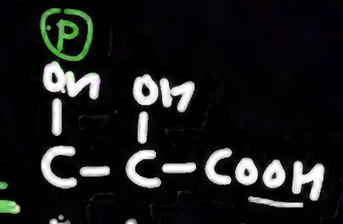
Dark Reaction steps

- location - Stroma
- Use - NADPH, ATP
- → Three major step









RUBISCO
Ribulose 1,5 Bis phosphate
Carboxylase Oxygenase

I Carboxylation

CO_2 Combine with RUBP(5c) to give First stable produce → two molecule of PGA

Substrate – RUBP + CO_2
Product – PGA(3c)

Enzyme – RUBISCO
↓ ↓
↳ Carboxylase

(In this case RUBISCO Act as Carboxylase)

II Reduction

PGA(3c) Acid Reduce to 3c (Sugar) — Triose phosphate

For Reduction – ATP, NADPH Require

III Regeneration

RUBP(5c) need to Regenrate, so that cycle Can countinue, ATP Require

1 CO_2 Fix → 3 ATP (2 Reduction + 1 Regenration)
(Requirement) 2 NADPH (Reduction step)

11.7.2 The Calvin Cycle

Calvin and his co-workers then worked out the whole pathway and showed that the pathway operated in a cyclic manner; the RuBP was regenerated. Let us now see how the Calvin pathway operates and where the sugar is synthesised. Let us at the outset understand very clearly that the Calvin pathway occurs in **all photosynthetic plants**; it does not matter whether they have C_3 or C_4 (or any other) pathways (Figure 11.8).

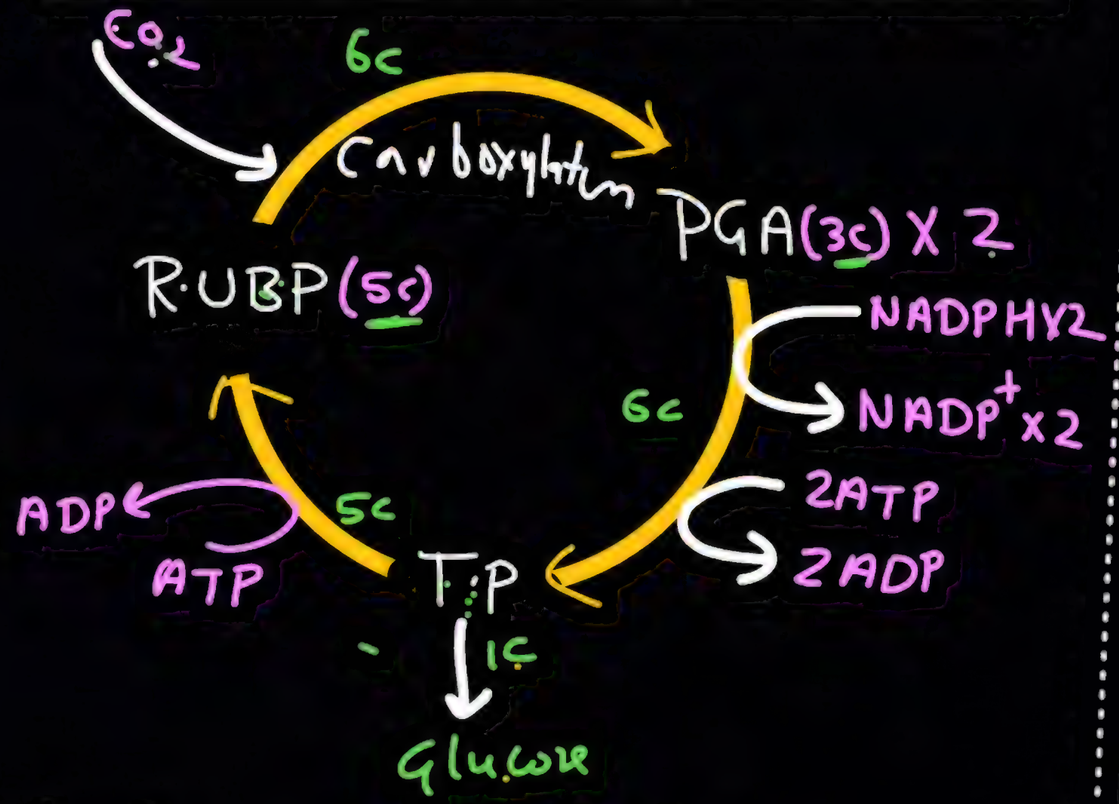
For ease of understanding, the Calvin cycle can be described under three stages: carboxylation, reduction and regeneration.

1. **Carboxylation** – Carboxylation is the fixation of CO_2 into a stable organic intermediate. Carboxylation is the most crucial step of the Calvin cycle where CO_2 is utilised for the carboxylation of RuBP. This reaction is catalysed by the enzyme RuBP carboxylase which results in the formation of two molecules of 3-PGA. Since this enzyme also has an oxygenation activity it would be more correct to call it RuBP carboxylase-oxygenase or **RuBisCO**.

2. **Reduction** – These are a series of reactions that lead to the formation of glucose. The steps involve utilisation of 2 molecules of ATP for phosphorylation and two of NADPH for reduction per CO_2 molecule fixed. The fixation of six molecules of CO_2 and 6 turns of the cycle are required for the formation of one molecule of glucose from the pathway.

3. **Regeneration** – Regeneration of the CO_2 acceptor molecule RuBP is crucial if the cycle is to continue uninterrupted. The regeneration steps require one ATP for phosphorylation to form RuBP.

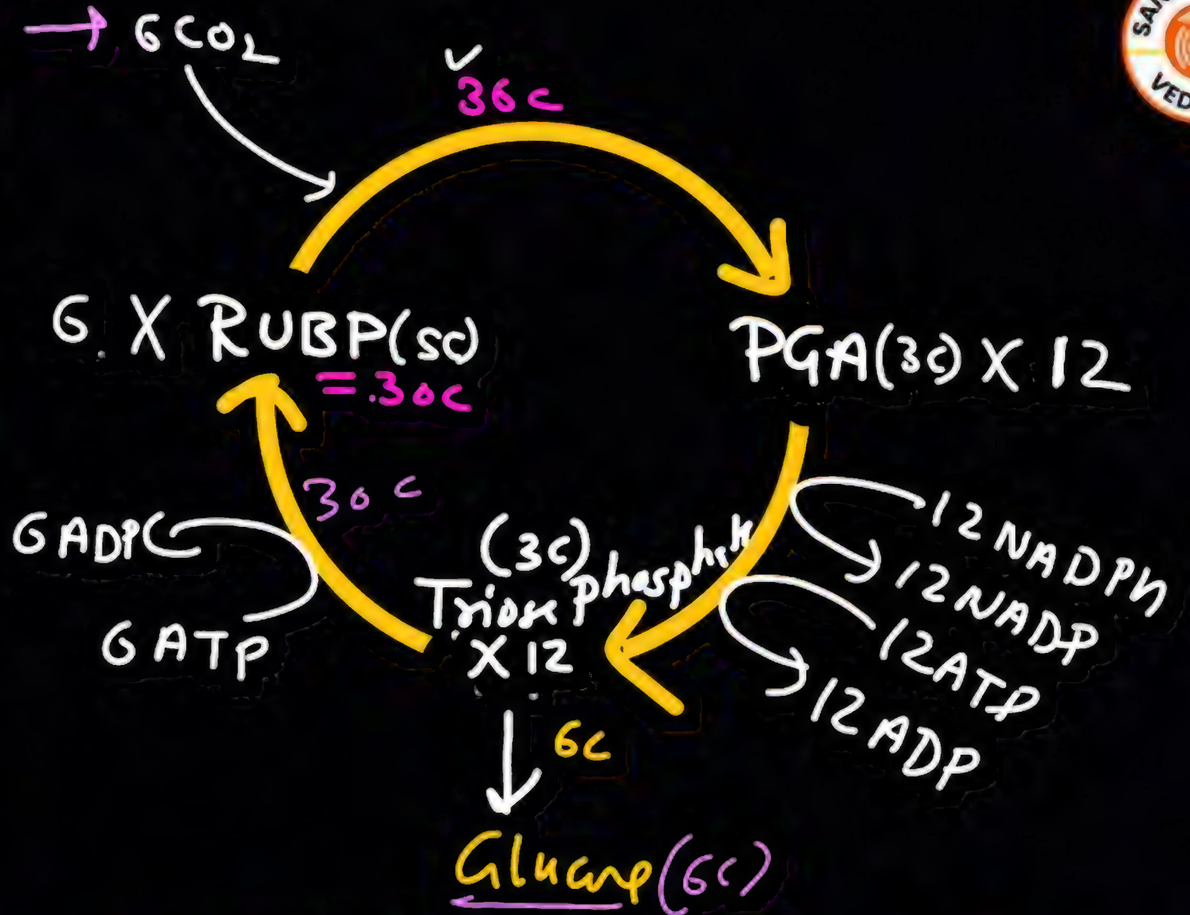
number of CO_2 to Fix one Glucose



1 Calvin cycle = 1 CO_2 Fix

3 ATP use

2 NADPH



6 turn Calvin cycle = 6 CO_2 Fix = 1 Glucose Form

18 ATP use

12 NADPH

3 ATP
2 NADPH

Hence for every CO_2 molecule entering the Calvin cycle 3 molecules of ATP and 2 of NADPH are required. It is probably to meet this difference in number of ATP and NADPH used in the dark reaction that the cyclic phosphorylation takes place.

To make one molecule of glucose 6 turns of the cycle are required. *Work out how many ATP and NADPH molecules will be required to make one molecule of glucose through the Calvin pathway.*

It might help you to understand all of this if we look at what goes in and what comes out of the Calvin cycle.

In	Out
Six CO_2	One glucose
18 ATP	18 ADP
12 NADPH	12 NADP

1 Glucose
↓
6 turn

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DOPA -05

Q1 RUBISCO — not true

(a) location stroma (b) Protein in nature (c) combine RUBP with CO_2 (d) involve in Reduction

Q2 Calvin use ___ and work on ___ to Discover Dark Rxn

(a) C^{14}, Fungi (b) C^{12}, Algae (c) C^{14} Bryophyte (d) C-14, Algae

Q3 Primary Acceptor of CO_2 in C-3 plant

(a) RUBP (b) Sugar (c) 5C (d) all

Q4 Step in which sugar Form in Biosynthetic phase

(a) Reduction (b) Regeneration (c) Carboxylation (d) Both a & b

Q5 Reduction of ___ occur in Stroma to give ___

(a) PGA, Acid (b) PGA, Sugar (c) PGA, triose phosphate (d) all

Q6 No. of CO_2 Require to Form two molecule of triose phosphate in Calvin cycle

(a) One (b) Six (c) three (d) Four

Q7 To Fix 6 CO_2 no. of ATP Require in Reduction step

(a) Six (b) twelve (c) Eighteen (d) nony

Q8 Steps in which Acid is Reduced into Sugar utilised

(a) ADP (b) ATP & NADPH (c) NADPH & Acid (d) none

Q9 Maximum number of Carbon

(a) Primary CO_2 Acceptor in C-3 cycle (b) First product C-4 cycle (c) Sugar From in Reduchim step (d) none

Q10 Steps not part of Biosynthetic phase

(a) Regeneration (b) Reduction (c) Photolysis (d) Carboxylation

MANTHAN NEET 2025 - 1.0 & 2.0

SANKALP NEET VEDANTU

Photosynthesis in higher plants

lecture - 07

Botany

TARUN SIR

Topics

(Summary - Smart one shot)

1. Experiments

2. location of Photosynthesis
   type of pigments
   Light Reaction
   Chemiosmotic hypothesis

2. Dark Reaction
   photorespiration
   C-4 plants

1. Factors Affecting Photosynthesis

ISO → FEG

3-4 Q (conceptual Question)

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Carboxylation

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$1 CO_2 + RUBP \longrightarrow 2\ T.P$

(a) One (b) Six (c) three (d) Four

Q7 To Fix 6 CO_2 no. of ATP Require in Reduction step

$18 \rightarrow 12 \rightarrow R$

$\rightarrow 6 - Re$

(a) Six (b) twelve (12) (c) Eighteen (d) nony

Q8 Steps in which Acid is Reduced into Sugar utlised

Acid $\longrightarrow$ Sugar

(a) ADP (b) ATP & NADPH (c) NADPH & Acid (d) none

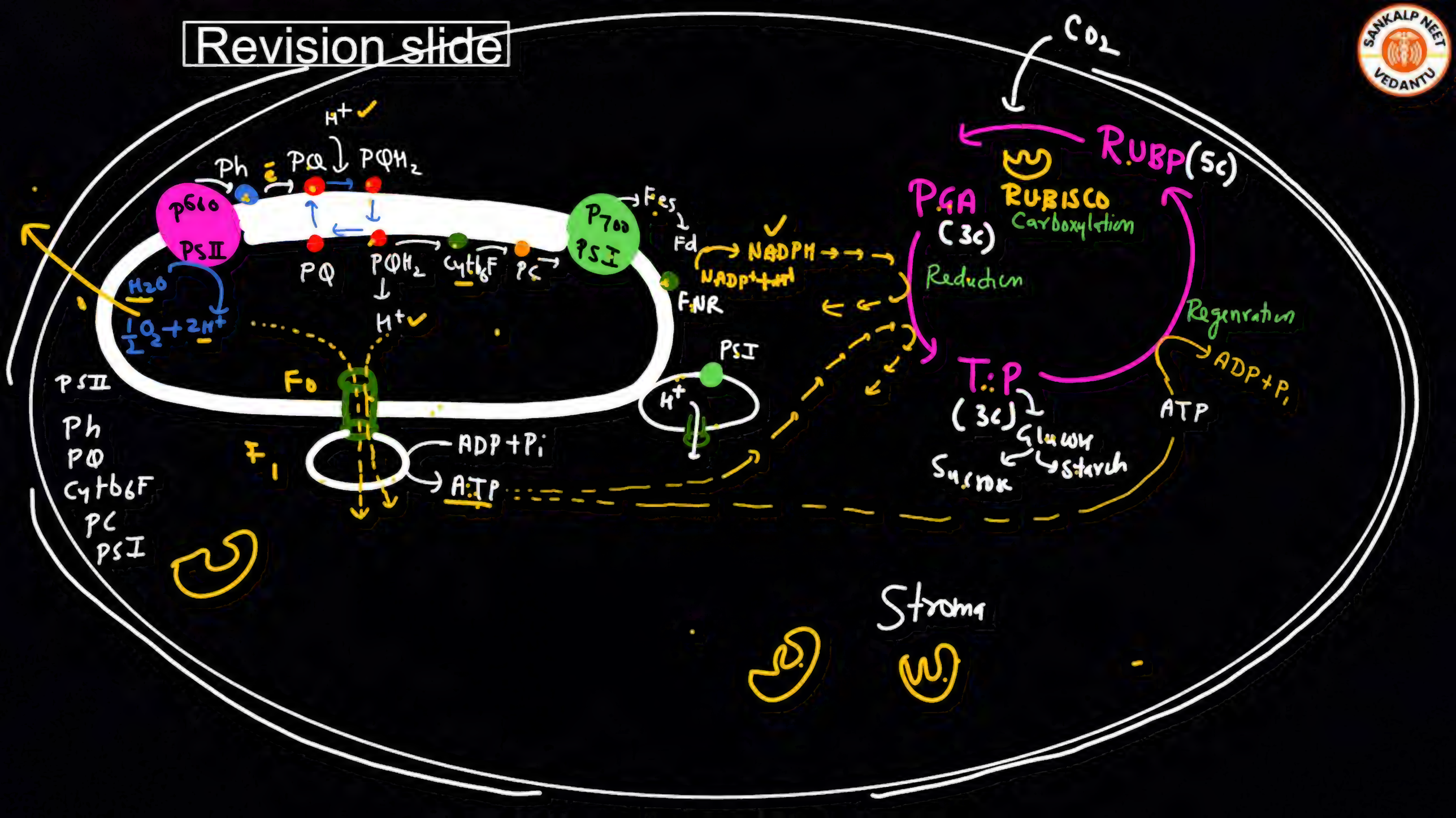
Q9 Maximum number of Carbon

(a) Primary CO_2 Acceptor in C-3 cycle (5C) (b) First product C-4 cycle (4C – OAA) (c) Sugar (3C – T.P) (d) none

Q10 Steps not part of Biosynthetic phase

(a) Regeneration (b) Reduction (c) Photolysis (d) Carboxylation

From in Reduction step


Revision slide
SANKALP NEET VEDANTU
CO_2
RUBP (5c)
RUBISCO
Carboxylation
PGA (3c)
Reduction
Regenration
ADP+Pi
ATP
T.P (3c)
Glucose
Starch
Sucrose
H^+
Ph
PQ
PQH_2
P680
PSII
P700
PSI
Fes
Fd
NADPH
NADP+ + H+
FNR
H_2O
$\frac{1}{2}O_2 + 2H^+$
PQ
PQH_2
$Cytb_6F$
PC
H^+
PSI
H^+
F_0
F_1
ADP+Pi
ATP
PSII
Ph
PQ
$Cytb_6F$
PC
PSI
Stroma

Some observation :-

→ O_2 produce → location → lumen

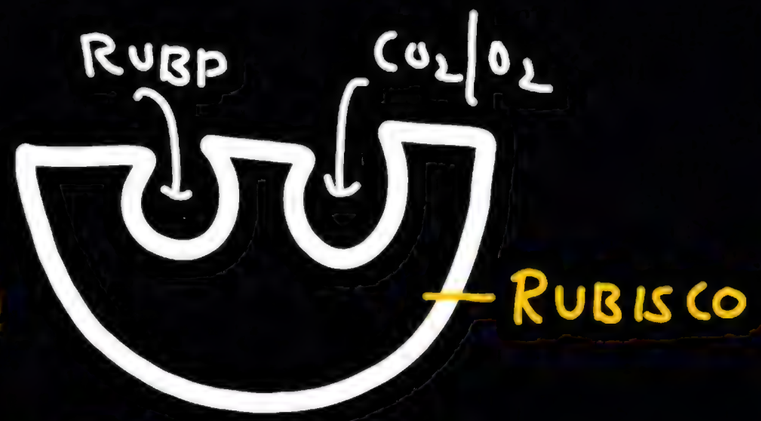
→ O_2 move From → lumen to stroma then outside

→ So does O_2 meet to Rubisco — Yes (in stroma)

Nature – O_2 conc. → 21 %

CO_2 conc. → 0.0038 %

About RUBISCO



- Name of Enzyme - RUBISCO - Ribulose 1,5 Bis phosphate
  C - Carboxylase O - Oxygenase
- Location → Stroma ✓
- Feature → It can Act as Both Carboxylase & Oxygenase

RUBISCO
- Carboxylase → RUBP + CO_2 ⟶ 2 Molecule PGA — In Calvin cycle
- Oxygenase → RUBP + O_2 ⟶ 1 Molecule PGA (3C) + Phosphoglycolate (2C) (Waste product)

- RUBISCO can Act as Oxygenase, But Preference is For CO_2
- This means, normally RUBISCO Act as Carboxylase But in Some special cases it can Act as Oxygenase.

conditions – RUBISCO Act as oxygenase

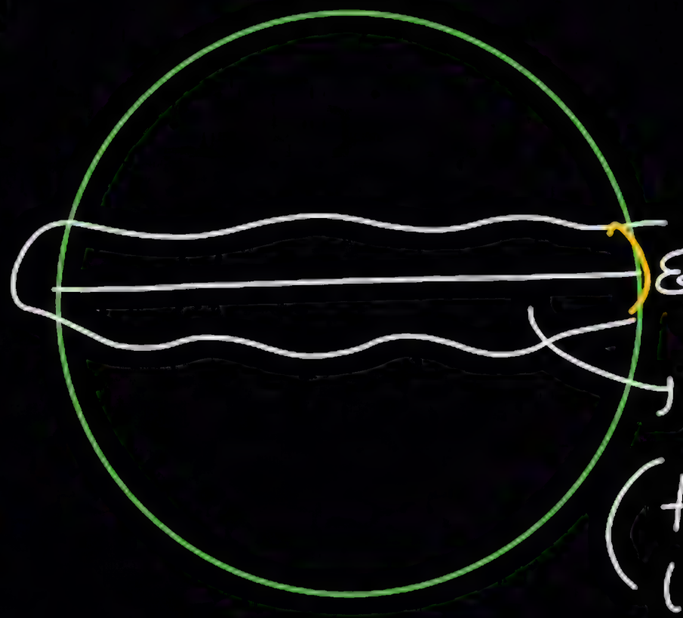
(a) High O_2 → Under Canopy of trees

(b) Low CO_2 conc. ↓

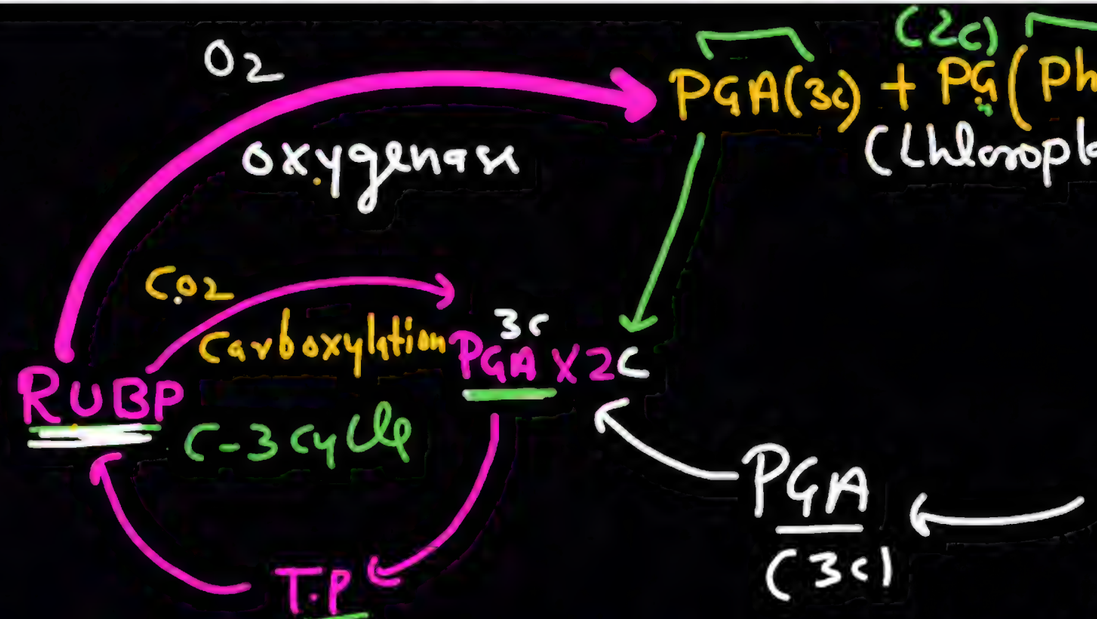
(c) High light intensity ↑

(d) High temp ↑

So, tropical plants, RUBISCO start to Act as oxygenase



What happens when RUBISCO Act as oxygenase



$2RUBP + 2CO_2 \longrightarrow 4\ PGA$ } Carboxylase

$2RUBP + 2O_2 \longrightarrow 2PGA + 2PG$ } Oxygenase

(10C) → 2×3C, 2×2C; 4 CO2 loss; 1 PGA (3C); Regenerate

2 molecule PG (4C)	I	1 molecule PGA (3C)
	CO_2 loss	

What is photorespiration

- In some special condition - RUBISCO - Act as Oxygenase & PGA and PG (Phospho glycolate)
- Occur in organelles → Chloroplast, Peroxisome, Mitochondria
- In photorespiration → CO_2 Release
  → ATP, NADPH - Utilised (yes - indirectly - CO_2 Fix in Calvin cycle)
  → ATP & Sugar - Form - NO
  → Phosphoglycolate (waste product)

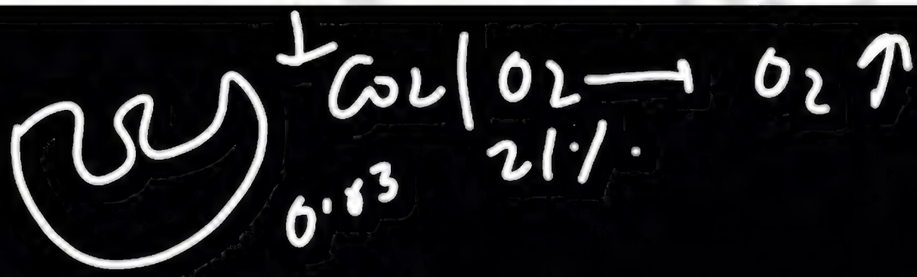
→ Productivity decrease of plant
→ Occur in tropical condition

11.9 PHOTORESPIRATION

Let us try and understand one more process that creates an important difference between C_3 and C_4 plants – **Photorespiration**. To understand photorespiration we have to know a little bit more about the first step of the Calvin pathway – the first CO_2 fixation step. This is the reaction where RuBP combines with CO_2 to form 2 molecules of 3PGA, that is catalysed by RuBisCO.

$$RuBP + CO_2 \xrightarrow{RuBisCo} 2 \times 3PGA$$

RuBisCO that is the most abundant enzyme in the world (Do you wonder why?) is characterised by the fact that its active site can bind to both CO_2 and O_2 - hence the name. *Can you think how this could be possible?* RuBisCO has a much greater affinity for CO_2 when the CO_2: O_2 is nearly equal. Imagine what would happen if this were not so! This binding is competitive. It is the relative concentration of O_2 and CO_2 that determines which of the two will bind to the enzyme.



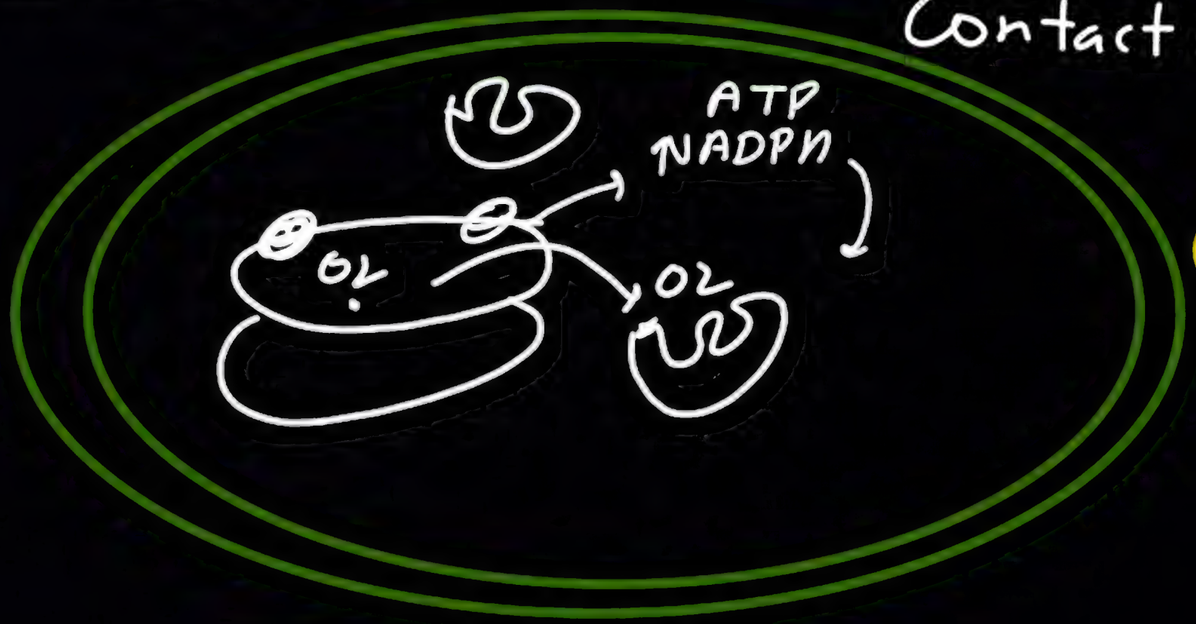
In C_3 plants some O_2 does bind to RuBisCO, and hence CO_2 fixation is decreased. Here the RuBP instead of being converted to 2 molecules of PGA binds with O_2 to form one molecule of phosphoglycerate and phosphoglycolate (2 Carbon) in a pathway called photorespiration. In the photorespiratory pathway, there is neither synthesis of sugars, nor of ATP. Rather it results in the release of CO_2 with the utilisation of ATP. In the photorespiratory pathway there is no synthesis of ATP or NADPH. The biological function of photorespiration is not known yet.

Reason For photorespiration

- RUBISCO come in contact with O_2 — Act as oxygenase

→ Result - Efficiency / Productivity decrease

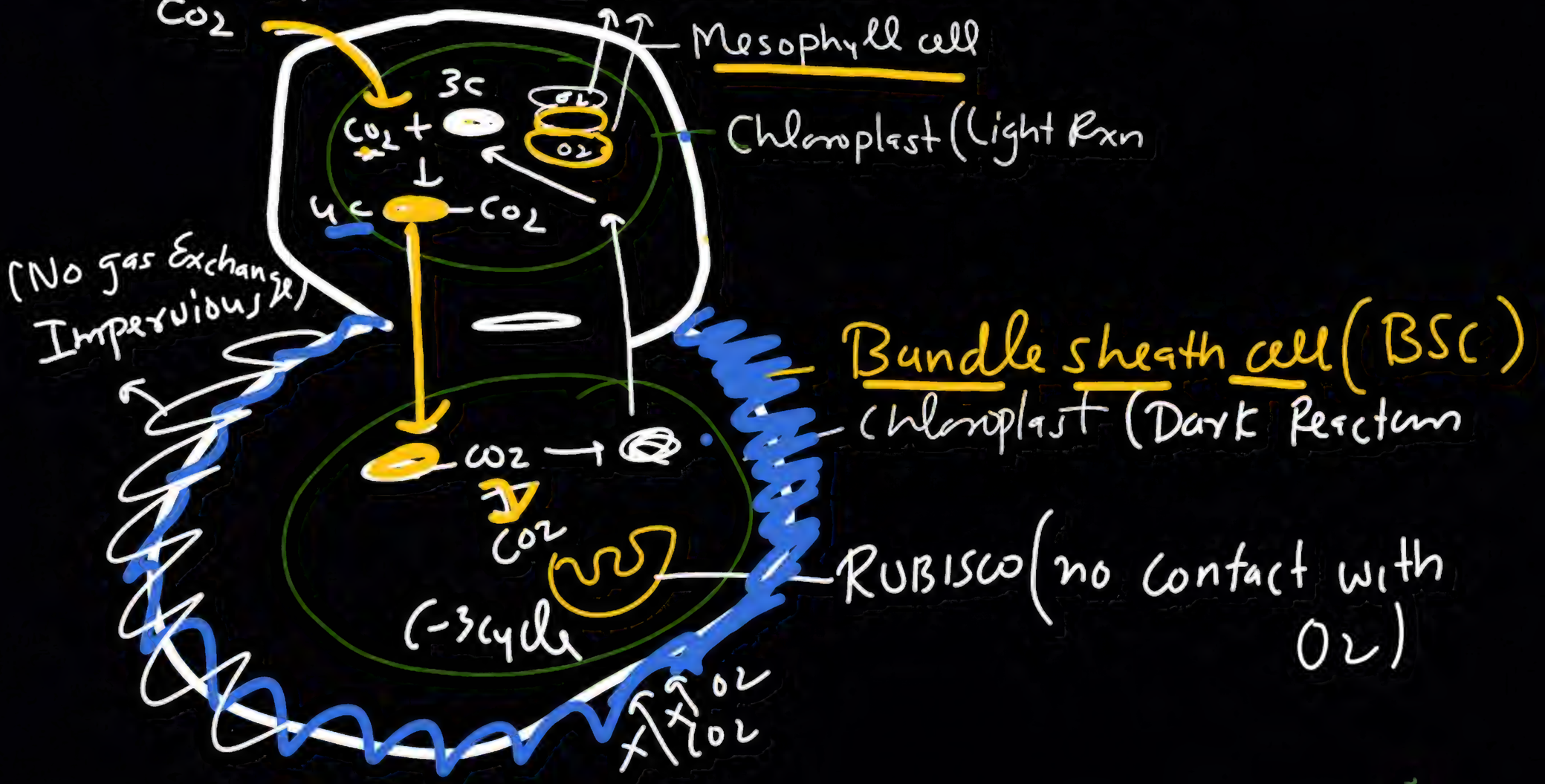
What is solution:- C-4 Plants → Somehow prevent O_2 to come in Contact with RUBISCO



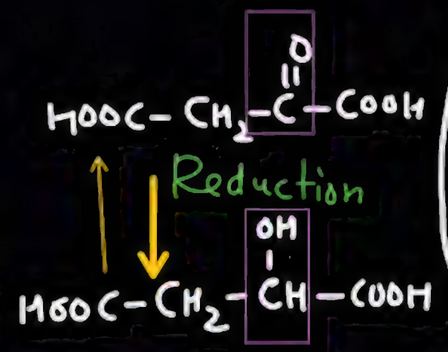
C-3 plant (Single cell - Mesophyll)
Light Rxn & Dark Same cell Rxn

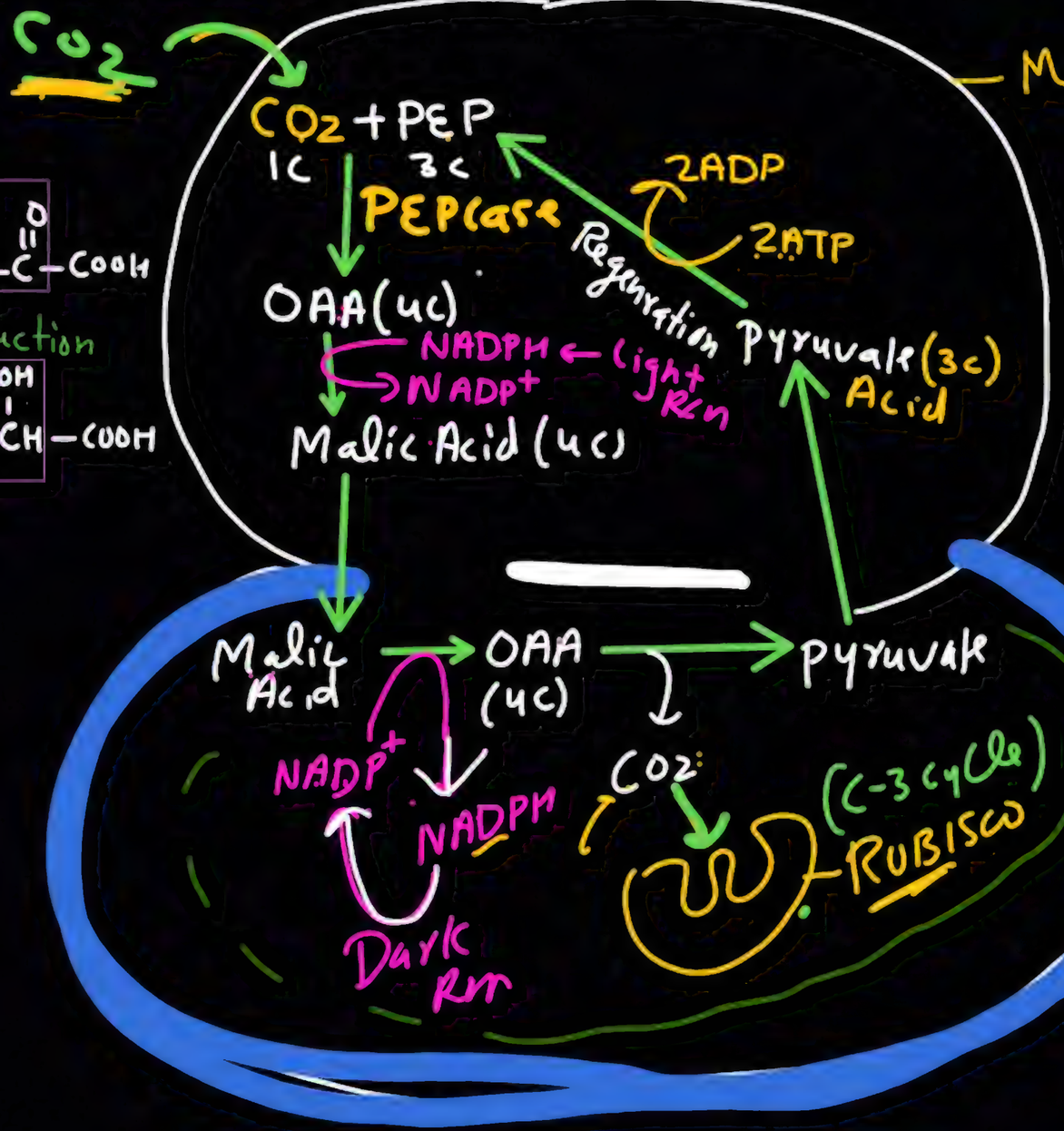
C-4 pathway | C-4 plants

- In C-4 plants → O_2 not come in contact with RUBISCO



Detail of C-4 pathway





PEP - Phospho enol pyruvate = 3C
(Primary CO_2 Acceptor)

OAA - 4C - Oxalo acetic Acid (First product)

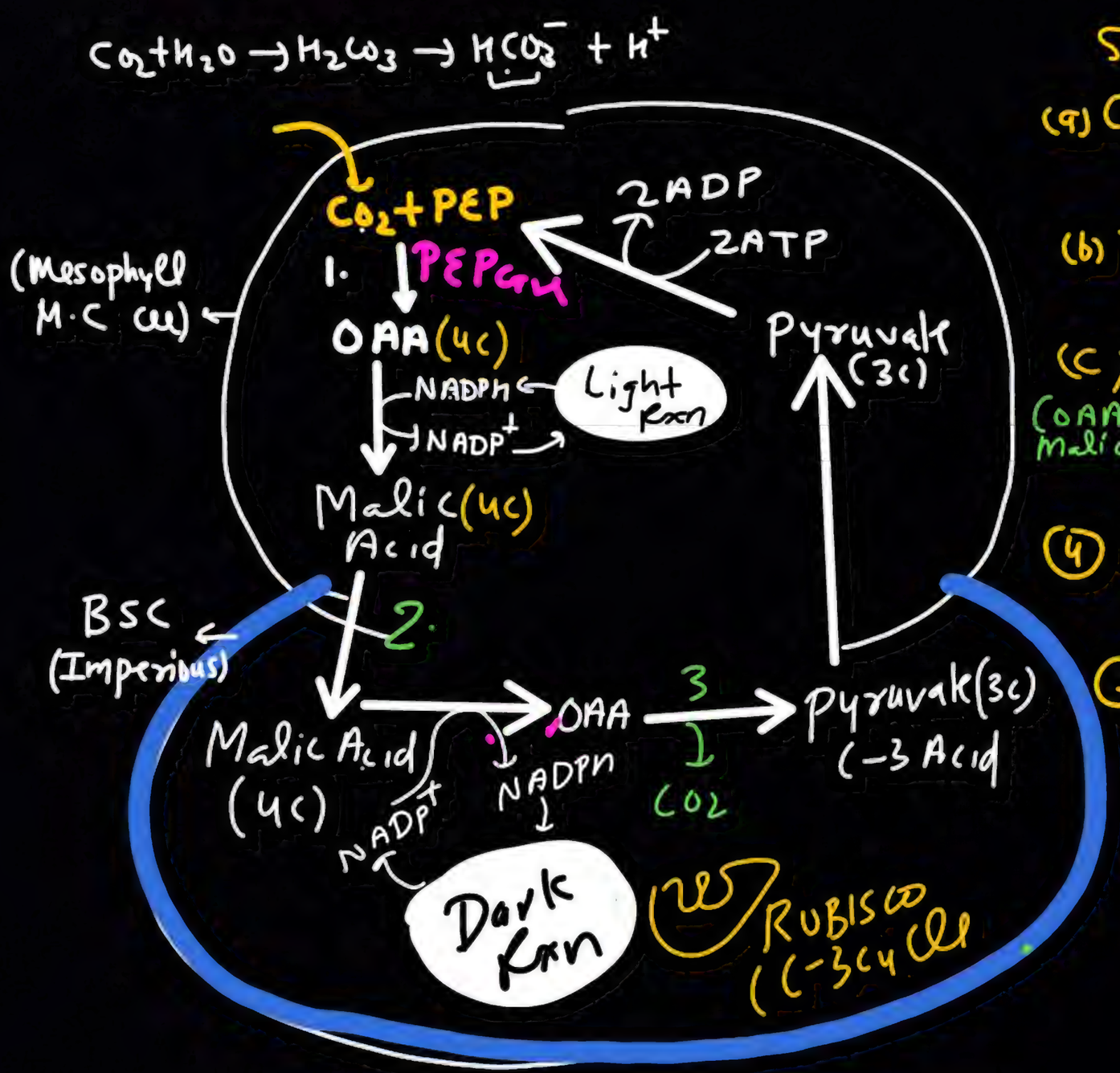
PEP case - Phosphoenol pyruvate Carboxylase

total ATP → 3 Calvin cycle + 2 C-4 Pathway
= 5 ATP Per CO_2

In C_4 plants photorespiration does not occur. This is because they have a mechanism that increases the concentration of CO_2 at the enzyme site. This takes place when the C_4 acid from the mesophyll is broken down in the bundle sheath cells to release CO_2 – this results in increasing the intracellular concentration of CO_2. In turn, this ensures that the RuBisCO functions as a carboxylase minimising the oxygenase activity.

Now that you know that the C_4 plants lack photorespiration, you probably can understand why productivity and yields are better in these plants. In addition these plants show tolerance to higher temperatures.

Based on the above discussion can you compare plants showing the C_3 and the C_4 pathway? Use the table format given in table 11.1 and fill in the information.



Steps

(a) Carboxylation → CO_2 combine with PEP (3C)
First product — OAA (4C)

(b) Transport → Transport of C-4 Acid From MC to BSC

(c) Decarboxylation – occur in BSC From C-4 Acid (OAA, Malic Acid) & C-3 Acid From CO_2 From goes into → C-3 cycle

(4) Transport – C-3 Acid transfer Back From BSC to MC

(5) Regenration – 2ATP use to Regenerate PEP

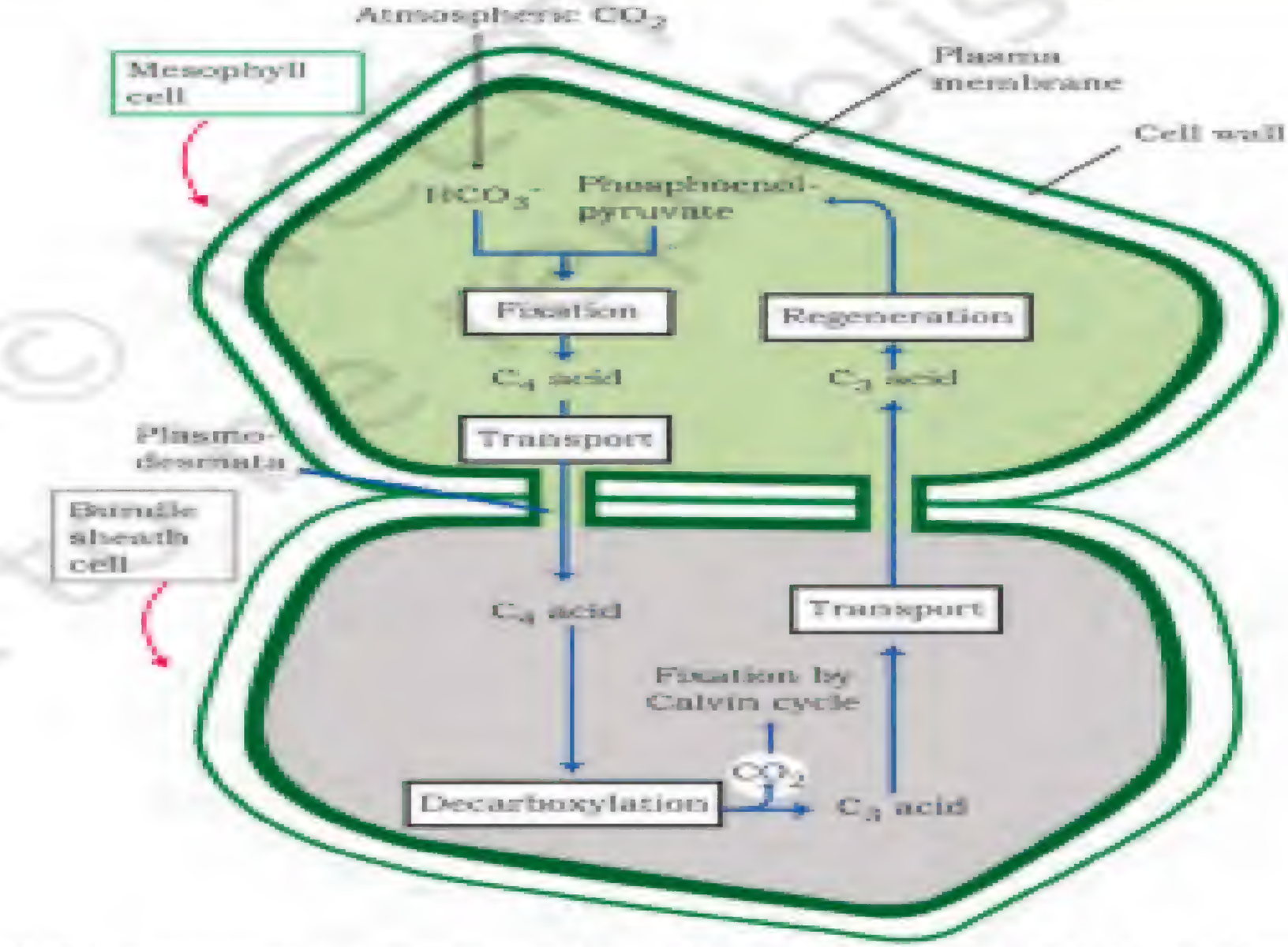


Figure 11.9 Diagrammatic representation of the Hatch and Slack Pathway

what we observe — C-4 pathway

(a) Number of cells involve → two cell (MC & BSC)

(b) Light Reaction occur in → Mesophyll cell

(c) Calvin cycle occur in → Bundle sheath cell

(d) initial carboxylation occur in → PEP + CO_2 → Mesophyll cell

(e) Primary CO_2 Acceptor → PEP (Phosphoenol pyruvak) — 3C

(f) Enzymes → PEPcase (only carboxylase) — MC

→ RUBISCO (Both carboxylase & oxygenase) → BSC

(g) Does calvin cycle occur → Yes, BSC

(h) Number of ATP to Fix One CO_2 → 5ATP
2 NADH

1 Glucose → 30 ATP
12 NADPH

Comparisons

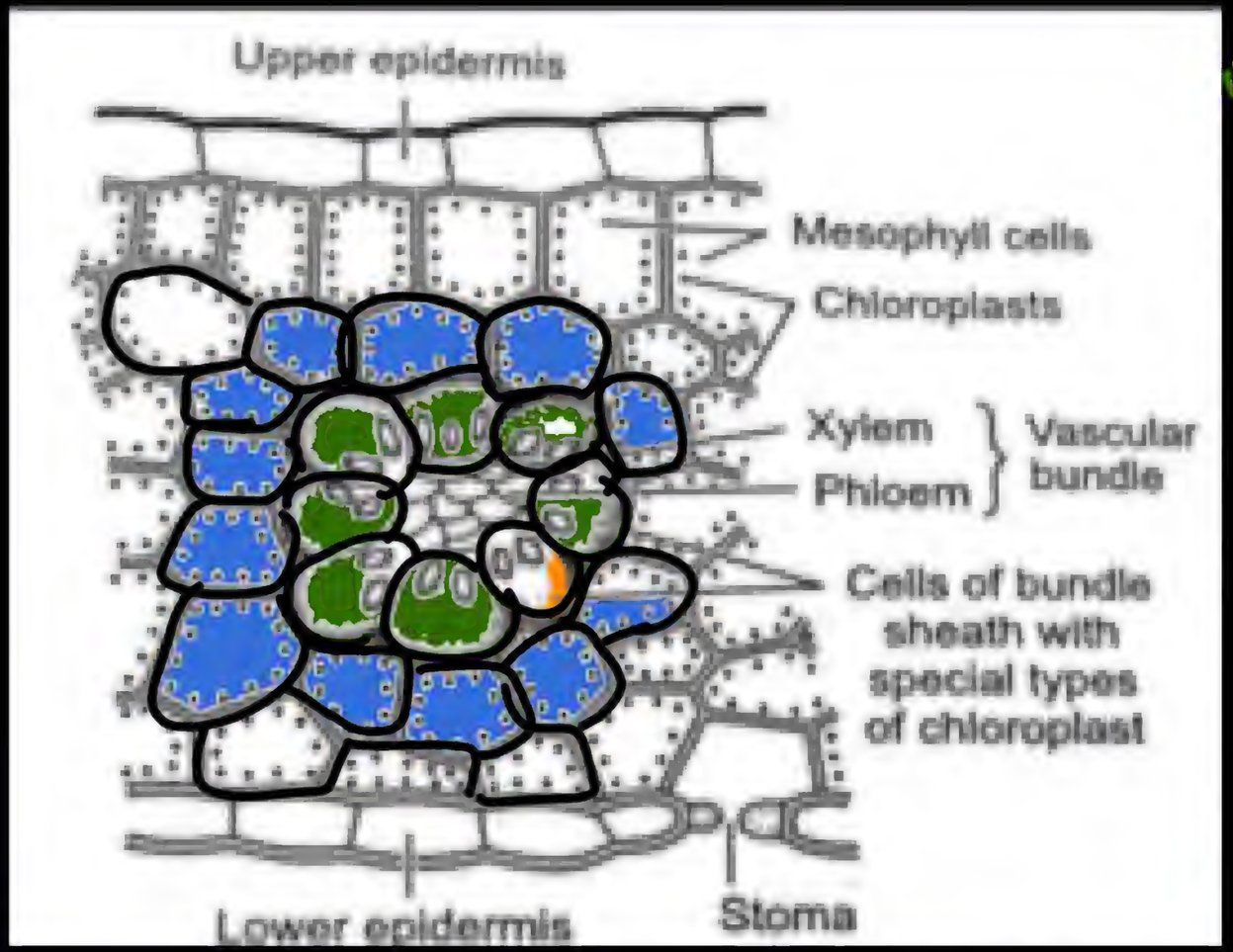
RUBISCO (C-4)
- in BSC
→ Carboxylase, Oxygenase Activity

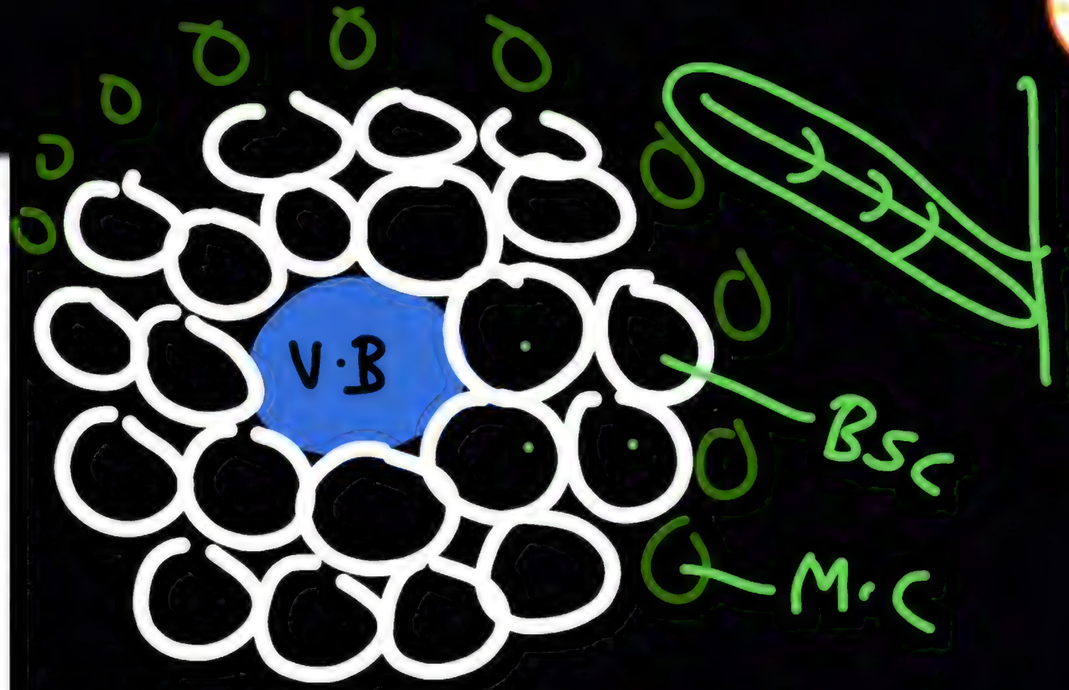
PEP Case ((-4)
- In MC (Mesophyll cell)
→ only carboxylase

Mesophyll cell
→ Pepcase present (C-4 cycle)
→ light Rxn
→ thin wall cell
→ Photolysis, PS II & PS I
Granal thylakoid
- less no. of chloroplast
→ O2 produce

Bundle sheath cell
RUBISCO present (C-3 cycle)
→ Dark Rxn
→ thick wall, impervious
→ No pholysis, PS I present, Stromal lamella (AGranal thylakoid)
- More no. of chloroplast
→ No O2 produce

Kranz Anatomy





- Kranz Anatomy - Bundle sheath cell impervious, thick wall, no intercellular space present in Form of Wreath (माला) & Mesophyll small size Single layer Surround BSC

DOPA – 05

Q1 Grand thylakoid present in
(a) Mesophyll cell in C-3 (b) Mesophyll cell in C-4 (c) BSC in C-4 (d) Both a & b

Q2 First product in photorespiration
(a) PEP (b) Phosphoglycolate (c) Pyruvate (d) OAA

Q3 Photorespiration which not occur
(a) CO_2 Release (b) Mitochondria, chloroplast Peroxisome Use (c) Sugar Form (d) ATP use

Q4 RUBISCO not true
(a) Mesophyll cell in C-3 plant (b) Most Abundant Enzyme (c) Act as Oxygenase Can (d) More affinity for Oxygen

Q5 Condition in which photorespiration not occur in C-3 plant
(a) Low CO_2 conc. (b) High O_2 conc. (c) Low light intensity (d) High light intensity

Q6 PSI & PS II Both present in
(a) BSC cell in C-4 plant (b) cell in which RUBISCO present in C-4 plant (c) Mesophyll cell in C-4 plant (d) all

Q7 Not true About Bundle sheath cell of C-4 plant
(a) C-3 cycle occur (b) Sugar Form (c) Granal thylakoid (d) Agranal thylakoid

Q8 Regenration step Require ____ Amount of ATP in C-3 cycle in C-4 plant per CO_2
(a) one (b) two (c) three (d) Four

Q9 Regenration step Require ____ Amount of ATP in C-4 cycle in C-4 plant per CO_2
(a) One (b) two (c) three (d) Four

Q10 Reduction step to make Sugar occur in ____ cell in C-4 plant
(a) Mesophyll cell (b) Bundle sheath cell (c) Sclovenchyma (d) all

Q11 Photysis occur in ____ cell in C-4 plant
(a) Mesophyll (b) BSC (c) Collonchyma (d) all

Q12 Hatch slack pathway not Require
(a) PEP case (b) RUBISCO (c) Carboxylation (d) Transport

Q13 Primary CO_2 Acceptor in C-4 plant give _____ molecule of First product when combine with CO_2
(a) one (b) two (c) three (d) Four

Q14 To Fix one Glucose molecule, no. of ATP Require in C-4 plant
(a) Five (b) Six (c) 30 (d) 18

Q15 No. of NADPH Require to Fix one Glucose in C-4 plant
(a) 12 (b) 18 (c) 30 (d) 3

	C-3 plants	C-4 plants
① number of cell		
② Primary CO_2 Acceptor		
③ First product		
④ Calvin cycle occur		
⑤ RUBISCO location		
⑥ No. of ATP to Fix 1 CO_2		

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Characteristics	C_3 Plants	C_4 Plants	Choose from
Cell type in which the Calvin cycle takes place			Mesophyll/Bundle sheath/both
Cell type in which the initial carboxylation reaction occurs			Mesophyll/Bundle sheath /both
How many cell types does the leaf have that fix CO_2.			Two: Bundle sheath and mesophyll One: Mesophyll Three: Bundle sheath, palisade, spongy mesophyll
Which is the primary CO_2 acceptor			RuBP/PEP/PGA
Number of carbons in the primary CO_2 acceptor			5 / 4 / 3
Which is the primary CO_2 fixation product			PGA/OAA/RuBP/PEP
No. of carbons in the primary CO_2 fixation product			3 / 4 / 5

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	C-3 plants	C-4 plants
Kranz Anatomy		
Photorespiration ↳ High O_2 ↳ low O_2 ↳ low light ↳ High light		
– Optimum temp.		
– Example		

C-3 C-4

No. of carbons in the primary CO_2 fixation product			3 / 4 / 5
Does the plant have RuBisCO?			Yes/No/Not always
Does the plant have PEP Case?			Yes/No/Not always
Which cells in the plant have Rubisco?			Mesophyll/Bundle sheath/none
CO_2 fixation rate under high light conditions			Low/ high/ medium
Whether photorespiration is present at low light intensities			High/negligible/sometimes
Whether photorespiration is present at high light intensities			High/negligible/sometimes
Whether photorespiration would be present at low CO_2 concentrations			High/negligible/sometimes
Whether photorespiration would be present at high CO_2 concentrations			High/negligible/sometimes
Temperature optimum			30-40 C/20-25C/above 40 C
Examples			Cut vertical sections of leaves of different plants and observe under the microscope for Kranz anatomy and list them in the appropriate columns.

MANTHAN NEET 2025 - 1.0 & 2.0

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Photosynthesis in higher plants

lecture - 08

Botany

TARUN SIR

Topics

(Summary – Smart one shot)

1 [Experiments]

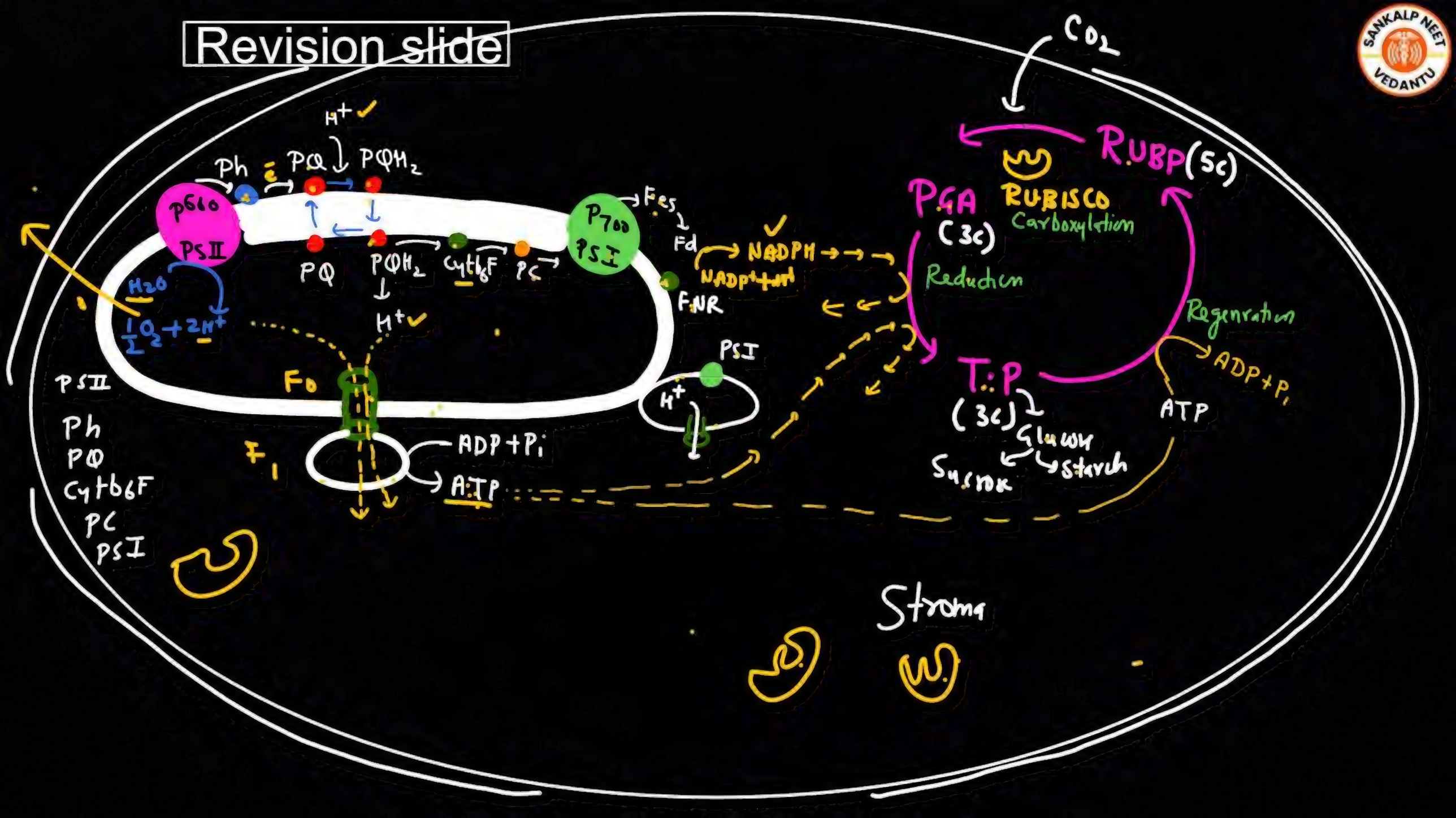
2 [
- location of Photosynthesis
- type of pigments
- Light Reaction
- Chemiosmotic hypothesis
]

2 [Dark Reaction
photorespiration
C-4 plants]

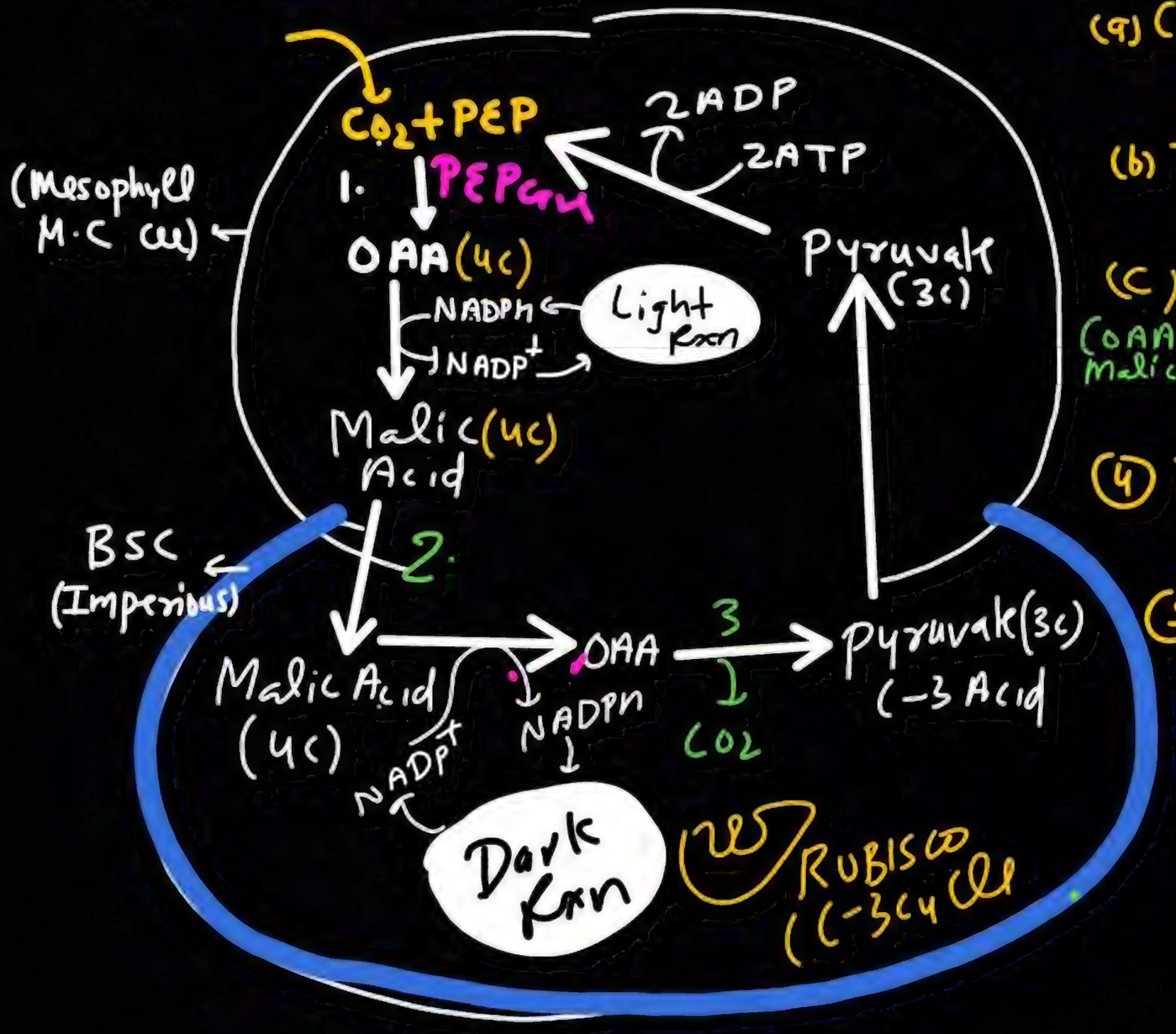
1 [Factors Affecting Photosynthesis]

[150 → FEG]

3-4 Q (conceptual Question)


Revision slide
SANKALP NEET VEDANTU
CO_2
RUBP (5C)
RUBISCO
Carboxylation
PGA
(3C)
Reduction
Regenration
ADP+Pi
ATP
T.P
(3C)
Glucose
Starch
Sucrose
H^+
Ph
PQ
PQH_2
P680
PSII
P700
PSI
Fes
Fd
NADPH
$NADP^+$ + H^+
FNR
H_2O
$\frac{1}{2}O_2 + 2H^+$
PQ
PQH_2
$Cytb_6F$
PC
H^+
PSI
H^+
F_o
F_1
ADP+Pi
ATP
PSII
Ph
PQ
$Cytb_6F$
PC
PSI
Stroma

$CO_2 + H_2O \rightarrow H_2CO_3 \rightarrow HCO_3^- + H^+$



Steps

(a) Carboxylation → CO_2 combine with PEP (3C)
First product — OAA (4C)

(b) Transport → Transport of C-4 Acid From MC to BSC

(c) Decarboxylation – occur in BSC From C-4 Acid (OAA, Malic Acid) & C-3 Acid From CO_2 From goes into → C-3 cycle

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Comparisons

RUBISCO (C-4)
- in BSC
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PEP Case (C-4)
- In MC (Mesophyll cell)
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Mesophyll cell
→ PEPCase present (C-4 cycle)
→ Light Rxn
→ thin wall cell
→ Photolysis, PS II & PS I
Granal thylakoid
- less no. of chloroplast
→ O2 produce

Bundle sheath cell
RUBISCO present (C-3 cycle)
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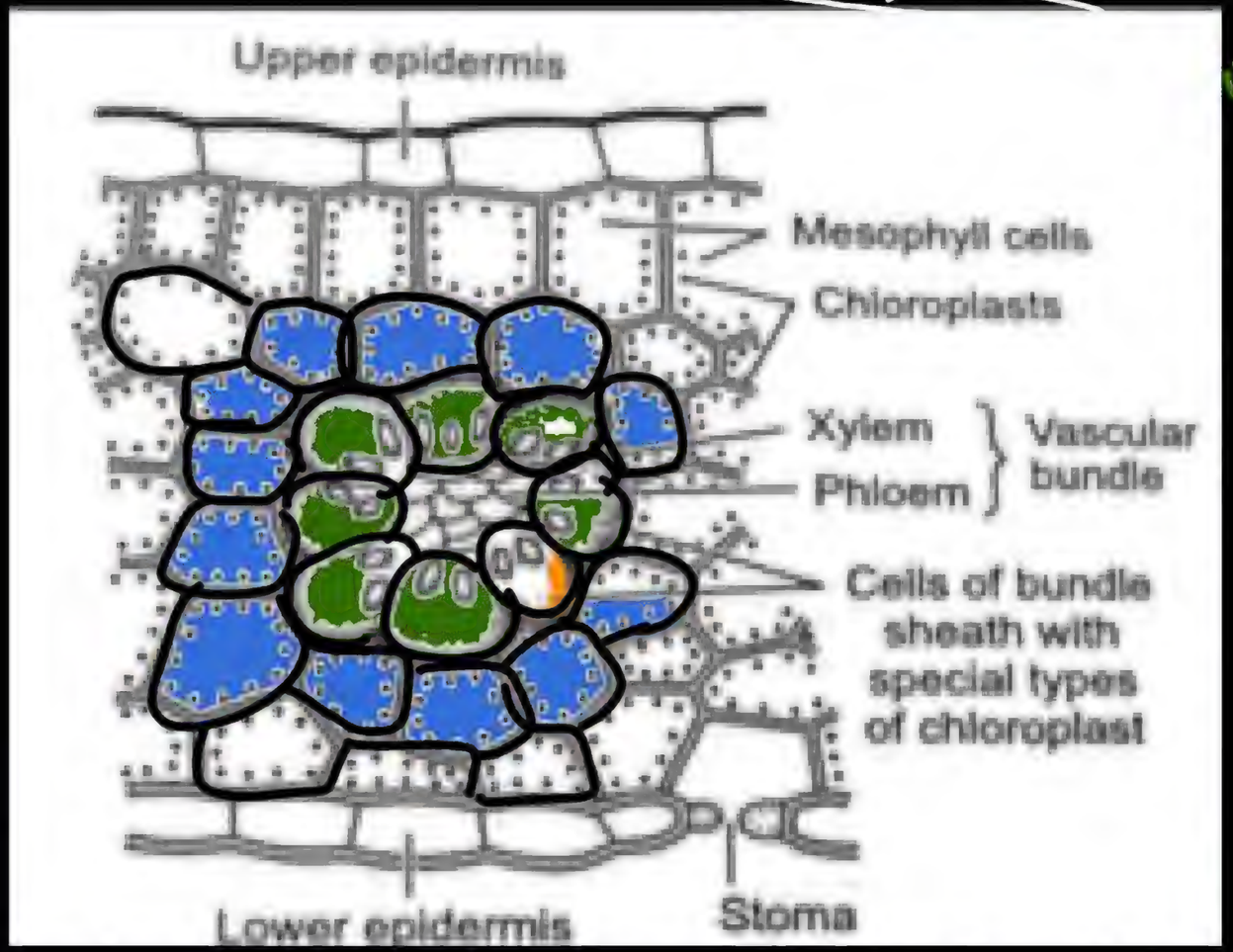
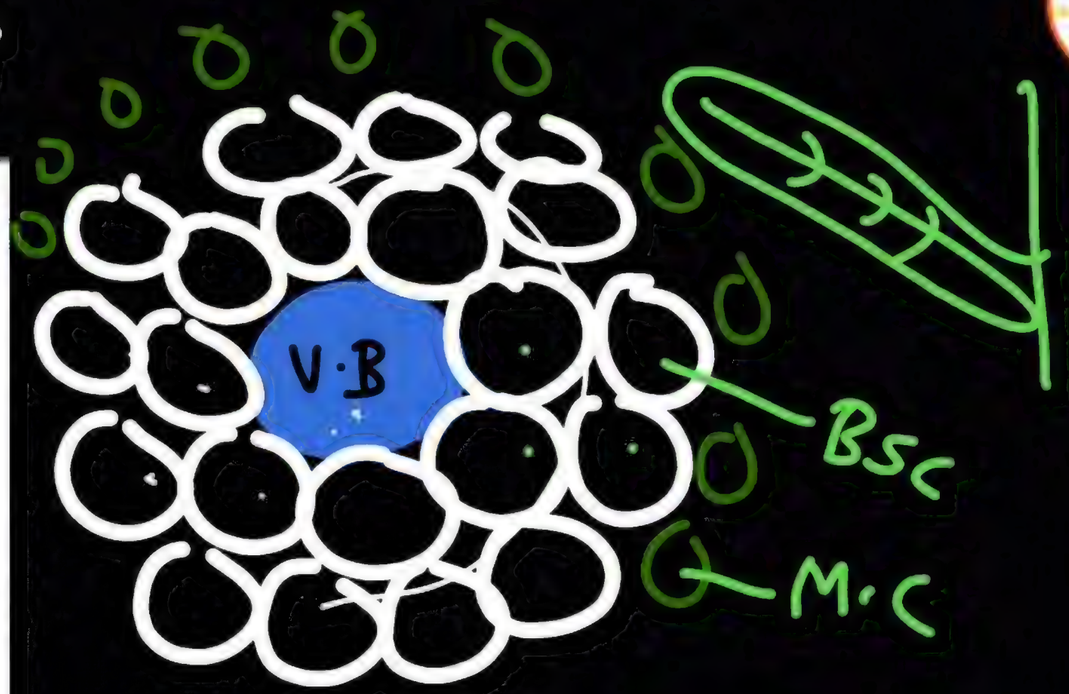
→ thick wall, impervious
→ No pholysis, PS I present, Stromal lamella
- More no. of chloroplast
→ No O2 produce

(AGranal thylakoid)

Kranz Anatomy





- Kranz Anatomy – Bundle sheath cell impervious, thick wall, no intercellular space present in Form of Wreath (माला) & Mesophyll small size Single layer surround BSC

DOPA – 05

Q1 Grana thylakoid present in
(a) Mesophyll cell in C-3 (b) Mesophyll cell in C-4 (c) BSC in C-4 (d) Both a & b

Q2 First product in photorespiration
(a) PEP (b) Phosphoglycolate (c) Pyruvate (d) OAA

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(a) CO_2 Release (b) Mitochondria, chloroplast, Peroxisome Use (c) Sugar Form (d) ATP use

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(a) Mesophyll cell (b) Bundle sheath cell (c) Sclorenchyma (d) all

Q11 Photysis occur in ____ cell in C-4 plant
(a) Mesophyll (b) BSC (c) Collenchyma (d) all

C-4 C-4 pathway

Q12 Hatch slack pathway } not Require

(a) PEP case (b) RUBISCO (c) Carboxylation (d) Transport

C-4 plant → C-3
→ C-4

Q13 Primary CO_2 Acceptor in C-4 plant give _____ molecule of First product when combine with CO_2

(a) one (b) two (c) three (d) Four

RUBP + CO_2 → PGA x2

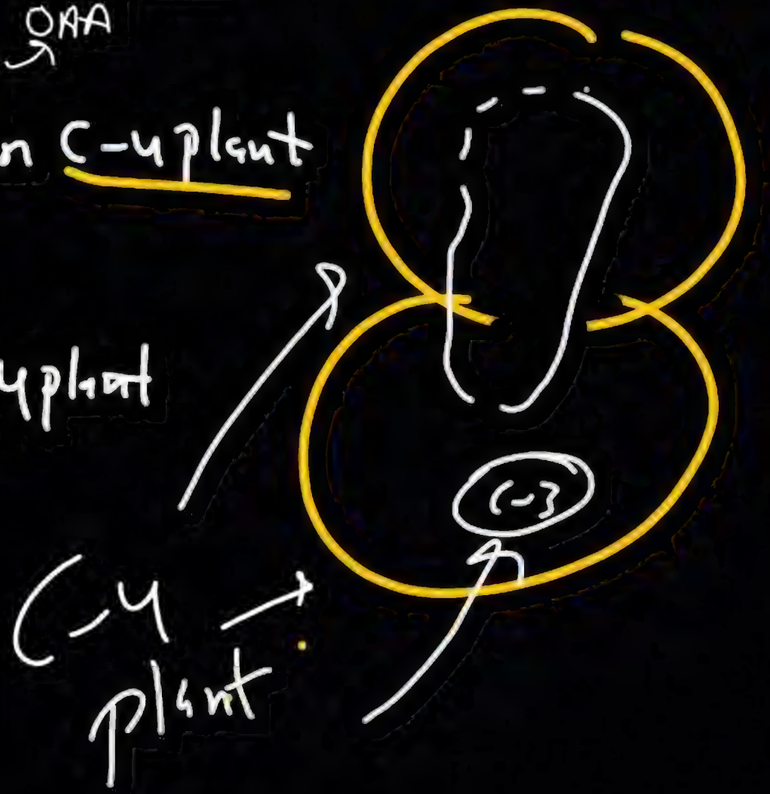
PEP + CO_2 → OAA

Q14 To Fix one Glucose molecule, no. of ATP Require in C-4 plant

(a) Five (b) Six (c) 30 (d) 18

Q15 No. of NADPH Require to Fix one Glucose in C-4 plant

(a) 12 (b) 18 (c) 30 (d) 3



	C-3 plants	C-4 plants
① number of cell	1 cell - Mesophyll	2 cell - MC, BSC
② Primary CO_2 Acceptor	RUBP (5C)	PEP (not Sugar) (3C)
③ First product	PGA (Acid) 3C	OAA (Acid) 4C
④ Calvin cycle occur	MC	BSC
⑤ RUBISCO location	MC	BSC
⑥ No. of ATP to Fix 1 CO_2	3ATP 2NADPH	5ATP 2NADPH

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	C-3 plants	C-4 plants
Kranz Anatomy	X	✓ (leaf)
Photorespiration		
↳ High O_2	✓	X
↳ low O_2	X	X
↳ low light	X	↑
↳ High light	✓	↑
– Optimum temp.	20–25	30–40
– Example	tomato, wheat, Banyan	Sorghum, Sugarcane, maize

Characteristics	C_3 Plants	C_4 Plants	Choose from
Cell type in which the Calvin cycle takes place	MC	BSC	Mesophyll/Bundle sheath/both
Cell type in which the initial carboxylation reaction occurs	MC	MC	Mesophyll/Bundle sheath /both
How many cell types does the leaf have that fix CO_2.	1	2	Two: Bundle sheath and mesophyll One: Mesophyll Three: Bundle sheath, palisade, spongy mesophyll
Which is the primary CO_2 acceptor	RUBP	PEP	RuBP/PEP/PGA
Number of carbons in the primary CO_2 acceptor	5	3	5 / 4 / 3
Which is the primary CO_2 fixation product	PGA	OAA	PGA/OAA/RuBP/PEP
No. of carbons in the primary CO_2 fixation product	3C	4C	3 / 4 / 5

C-3 C-4

No. of carbons in the primary CO_2 fixation product	3C	4C	3 / 4 / 5
Does the plant have RuBisCO? ✓	Yes ✓	Yes ✓	Yes/No/Not always
Does the plant have PEP Case?	→ NO	Yes ✓	Yes/No/Not always
Which cells in the plant have Rubisco?	MC	BSC	Mesophyll/Bundle sheath/none
CO_2 fixation rate under high light conditions	Low	High	Low/ high/ medium
Whether photorespiration is present at low light intensities	Neg	Neg	High/negligible/sometimes
Whether photorespiration is present at high light intensities	High	Neg	High/negligible/sometimes
Whether photorespiration would be present at low CO_2 concentrations	High	Neg	High/negligible/sometimes
Whether photorespiration would be present at high CO_2 concentrations	Neg	Neg	High/negligible/sometimes
Temperature optimum			30-40 C/20-25C/above 40 C
Examples			Cut vertical sections of leaves of different plants and observe under the microscope for Kranz anatomy and list them in the appropriate columns.

11.8 The C_4 Pathway

Plants that are adapted to dry tropical regions have the C_4 pathway mentioned earlier. Though these plants have the C_4 oxaloacetic acid as the first CO_2 fixation product they use the C_3 pathway or the Calvin cycle as the main biosynthetic pathway. Then, in what way are they different from C_3 plants? This is a question that you may reasonably ask.

C_4 plants are special: They have a special type of leaf anatomy, they tolerate higher temperatures, they show a response to high light intensities, they lack a process called photorespiration and have greater productivity of biomass. Let us understand these one by one.

It would be interesting for you to collect leaves of diverse species of plants around you and cut vertical sections of the leaves. Observe under the microscope – look for the bundle sheath around the vascular bundles. The presence of the bundle sheath would help you identify the C_4 plants.

Now study the pathway shown in Figure 11.9. This pathway that has been named the Hatch and Slack Pathway, is again a cyclic process. Let us study the pathway by listing the steps.

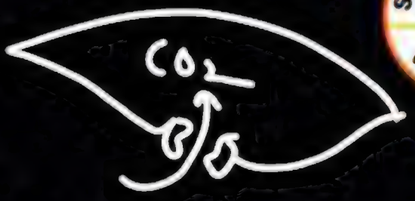
The primary CO_2 acceptor is a 3-carbon molecule **phosphoenol pyruvate (PEP)** and is present in the mesophyll cells. The enzyme responsible for this fixation is **PEP carboxylase** or PEPcase. It is important to register that the mesophyll cells lack RuBisCO enzyme. The C_4 acid OAA is formed in the mesophyll cells.

It then forms other 4-carbon compounds like malic acid or aspartic acid in the mesophyll cells itself, which are transported to the bundle sheath cells. In the bundle sheath cells these C_4 acids are broken down to release CO_2 and a 3-carbon molecule.

The 3-carbon molecule is transported back to the mesophyll where it is converted to PEP again, thus, completing the cycle.

The CO_2 released in the bundle sheath cells enters the C_3 or the Calvin pathway, a pathway common to all plants. The bundle sheath cells are

Factors affecting photosynthesis



- Two type of Factors Affect Rate

(a) Extrinsic / External → Light, CO_2 conc., temp., water] (f) Internal CO_2

(b) Internal / Intrinsic – Also known as plant Factor

Example – (a) Size of leaf (c) Orientation (e) No. of Mesophyll cell
(b) Age of leaf (d) no. of stomata (f) No. of chloroplast
(g) Amount of Chlorophyll

(old leaf - less photosynthesis) (more stomata, more CO_2 Enter)

Internal Factor ① Depend on Genetic predisposition (Genes decide Size previously)
of plant
② Growth of Plant

An understanding of the factors that affect photosynthesis is necessary. The rate of photosynthesis is very important in determining the yield of plants including crop plants. Photosynthesis is under the influence of several factors, both internal (plant) and external. The plant factors include the number, size, age and orientation of leaves, mesophyll cells and chloroplasts, internal CO_2 concentration and the amount of chlorophyll. The plant or internal factors are dependent on the genetic predisposition and the growth of the plant.

External Factor

law of limiting Factor

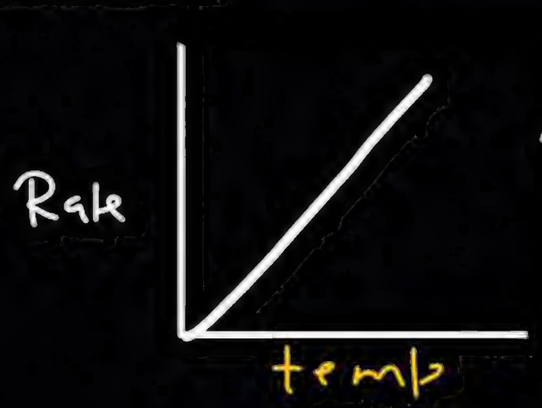
F.F Blackman – 1905

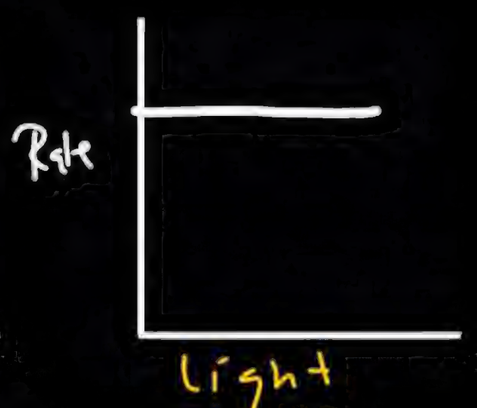
– Rate of photosynthesis → Control By more than one External Factor – [light, CO_2, temp, water]

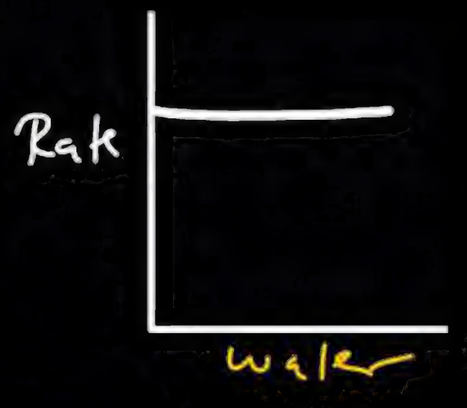
law – Any Biochemical process, Control By more than one Factor
Rate is Determined By Factor which is most limiting (very less)
Maximum value – optimus less than maximum value – Sub optimum

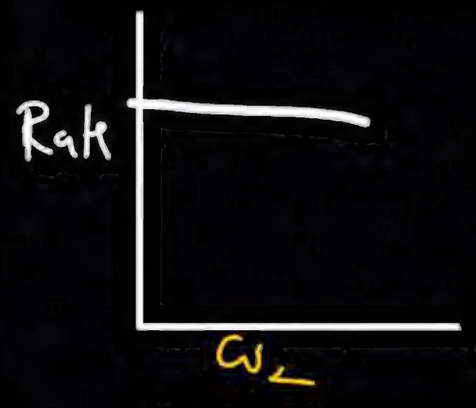
Explanation:- In summer → Early morning Rate depend on light (low light)
around 10.00 am (High light) Rate depend on water

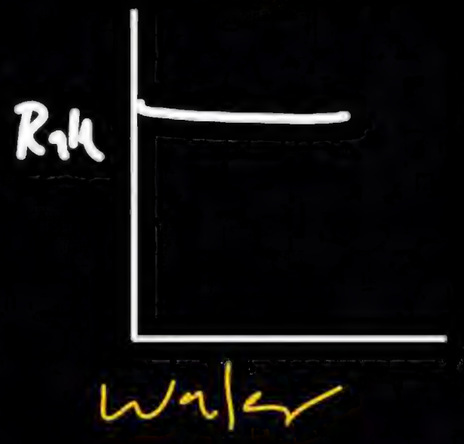
Explanation

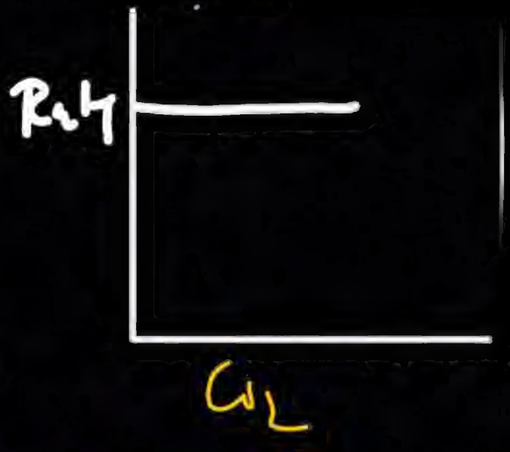












How to identify Rate depend on → low light intensity
low temp.

Q1 In Low light intensity Rate of photosynthesis depend on
(a) temp (b) light (c) CO_2 (d) Water

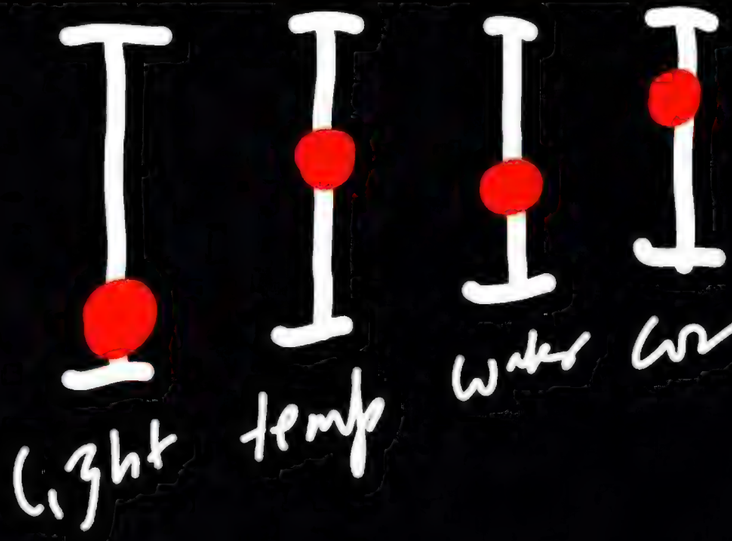
Q2 In afternoon, when Sufficient light
Which Factor can't control Rate
(a) light (b) temp (c) CO_2 (d) all

Rate ∝ light

Q3 At High light intensity, increase in temp Show
(a) Inc. Rate of Photosynthesis (b) dec. Rate (c) No Effect (d) First inc & then dec

When several factors affect any [bio] chemical process, Blackman's (1905) **Law of Limiting Factors** comes into effect. This states the following:

If a chemical process is affected by more than one factor then its rate will be determined by the factor which is nearest to its minimal value: it is the factor which directly affects the process if its quantity is changed.



max value – optimum

min value

Q At low light intensity
Rate ∝ light

The external factors would include the availability of sunlight, temperature, CO_2 concentration and water. As a plant photosynthesises, all these factors will simultaneously affect its rate. Hence, though several factors interact and simultaneously affect photosynthesis or CO_2 fixation, usually one factor is the major cause or is the one that limits the rate. Hence, at any point the rate will be determined by the factor available at sub-optimal levels.

Light

400-700 nm - Responsible For photosynthesis (PAR - Photosynthetically Active Radiation)

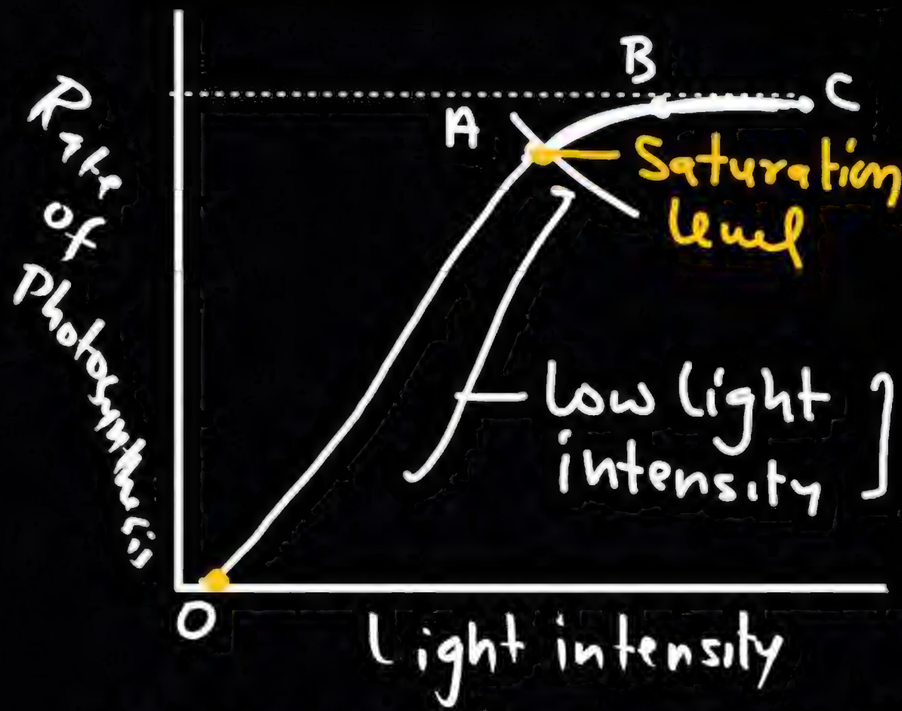
Light three component — ① Amount of Light / Day length → Winter - less, Summer - More

- ② Wavelength
- ③ Intensity → Afternoon - more intensity Sunlight

- All three factor have impact on photosynthesis
- Rate of Photosynthesis control By → Intensity of light

Optimam light intensity - High light intensity

- light intensity very high → (Chlorophyll destroy → Photosynthesis decrease)



Low light intensity → Rate ∝ Light intensity
(O to A)

Beyond A ⟶ High light intensity → Other Factor limiting (water, CO_2, temp)

* 10% light/Sunlight is Sufficient For photosynthesis
* Light is limiting, when plant is in shade — like under Forest

Plant two type → Can grow very low light intensity — Shade plant
→ Saturation come at high light intensity — Sun Plant

11.10.1 Light

We need to distinguish between light quality, light intensity and the duration of exposure to light, while discussing light as a factor that affects photosynthesis. There is a linear relationship between incident light and CO_2 fixation rates at low light intensities. At higher light intensities, gradually the rate does not show further increase as other factors become limiting (Figure 11.10). What is interesting to note is that light saturation occurs at 10 per cent of the full sunlight. Hence, except for plants in shade or in dense forests, light is rarely a limiting factor in nature. Increase in

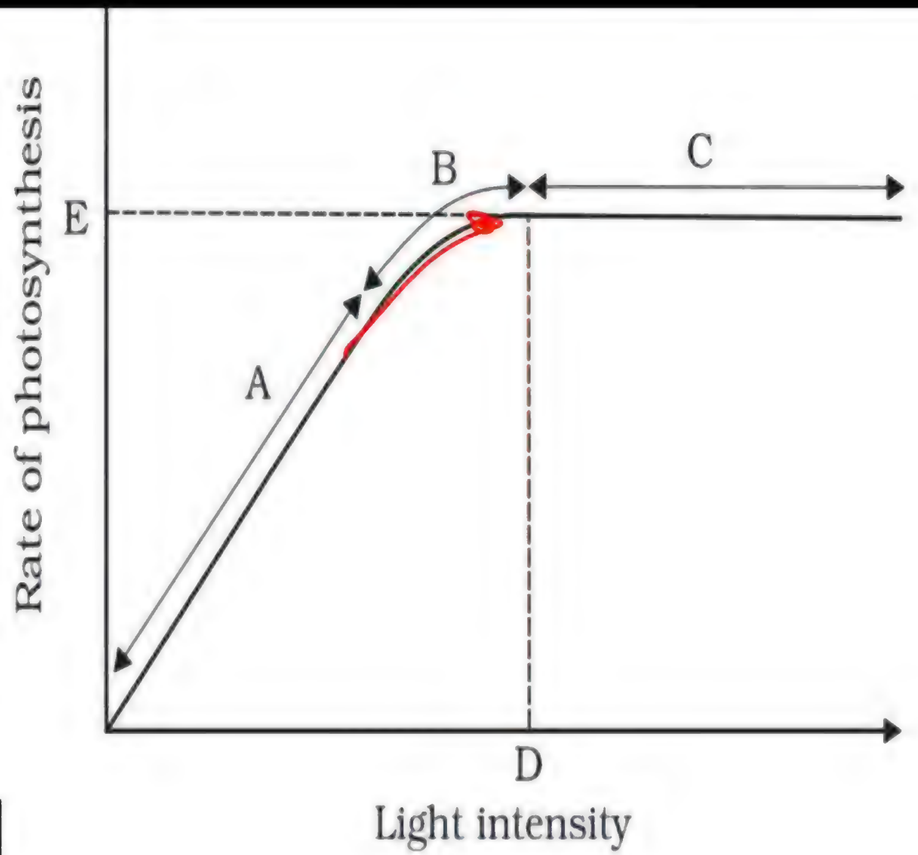
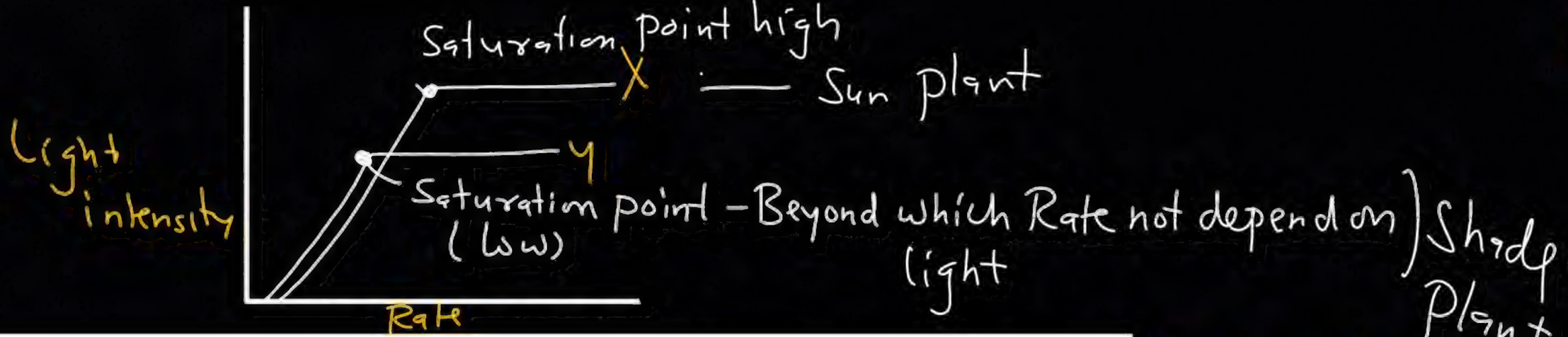
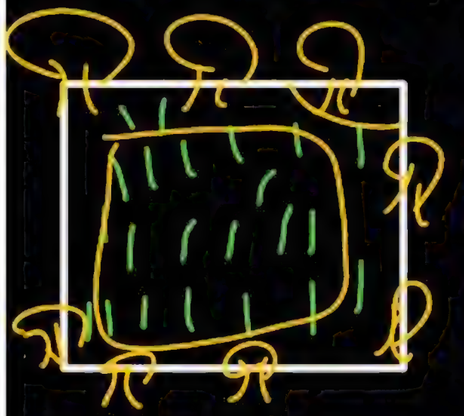


Figure 11.10 Graph of light intensity on the rate of photosynthesis



incident light beyond a point causes the breakdown of chlorophyll and a decrease in photosynthesis.



Carbondioxide

Environment – 0.038 % | 380ppm | 380 µl | litre → microlitre

→ CO_2 conc. → Increase → they Rate of Photosynthesis)

(380 ppm → 400 ppm → 500 ppm → more than that plant Show negative impact

(Beyond 500 ppm CO_2 → Plant get harm)

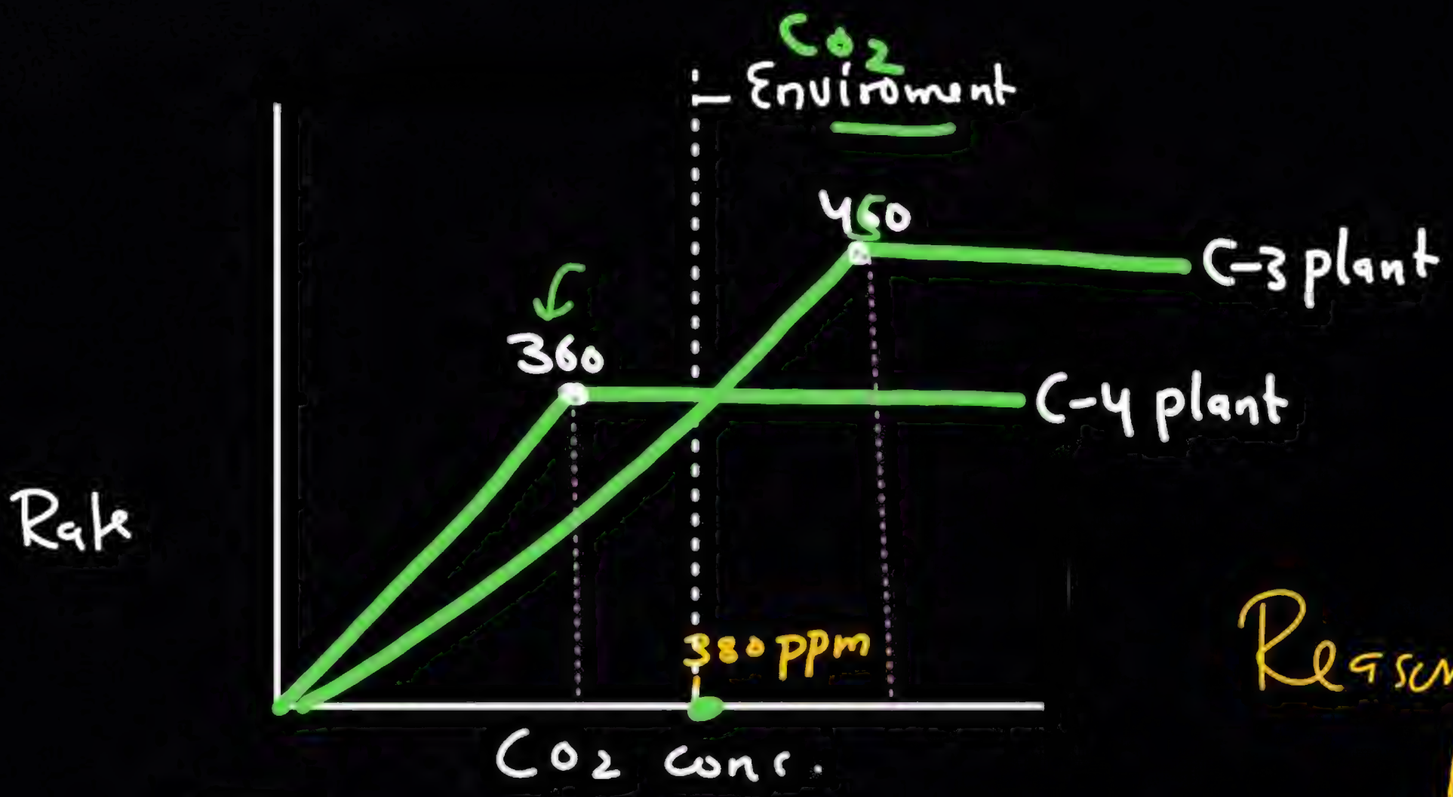
→ C-3 plant → Saturation → 450 ppm ✓

(CO2 conc. at which max. photosynthesis)

→ C-4 plant – Saturation → 360 ppm ✓

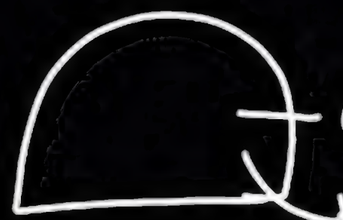
- At low light intensity → Increase in CO_2 conc. no Effect on Both C-3 & C-4 plant

(Rate ∝ light)



→ At high light intensity, increase in CO_2 (More than 380) will benefit C-3 more than C-4

Reason → C-4 Saturation Already Achieved, C-3 plant need more CO_2 For saturation



Green house (CO_2 conc. high)

→ Grow C-3 plant / Green house plant

(Ex- tomato, Bell pepper)

11.10.2 Carbon dioxide Concentration

Carbon dioxide is the major limiting factor for photosynthesis. The concentration of CO_2 is very low in the atmosphere (between 0.03 and 0.04 per cent). Increase in concentration upto 0.05 per cent can cause an increase in CO_2 fixation rates; beyond this the levels can become damaging over longer periods.

The C_3 and C_4 plants respond differently to CO_2 concentrations. At low light conditions neither group responds to high CO_2 conditions. At high light intensities, both C_3 and C_4 plants show increase in the rates of photosynthesis. What is important to note is that the C_4 plants show saturation at about 360 $\mu l L^{-1}$ while C_3 responds to increased CO_2 concentration and saturation is seen only beyond 450 $\mu l L^{-1}$. Thus, current availability of CO_2 levels is limiting to the C_3 plants.

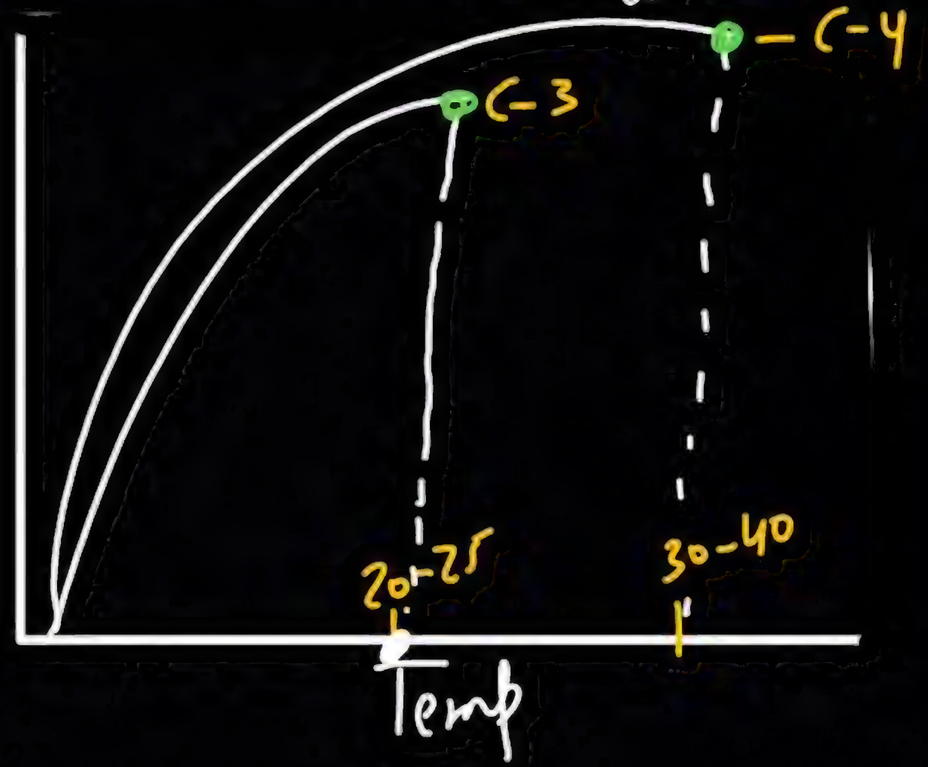
Q Environment CO_2 is not limiting for
(a) Neem (b) tomato (c) Sugarcane (d) Bell pepper

Temperature

→ Temp. mainly affect Enzymes

→ Light Rxn & Dark Rxn Both have Enzyme (But Dark Rxn more Enzyme)
So temperature affect More – Dark Rxn

→ C_3 plant & C-4 plant – Different temperature optimum



(temp optimum low)
Temperate plant

Tropical Plants – temp optimum high

11.10.3 Temperature

The dark reactions being enzymatic are temperature controlled. Though the light reactions are also temperature sensitive they are affected to a much lesser extent. The C_4 plants respond to higher temperatures and show higher rate of photosynthesis while C_3 plants have a much lower temperature optimum.

The temperature optimum for photosynthesis of different plants also depends on the habitat that they are adapted to. Tropical plants have a higher temperature optimum than the plants adapted to temperate climates.

Water

- Requirement of water → Light Rxn (Photolysis) — Water of stroma Enter into lumen via

- Water indirect impact Rate

(a) Water stress (Afternoon) → less water
↓
Stomata close → CO_2 not Enter
↓
Rate of Photosynthesis dec.

(b) Water stress → Leaf wilt

(Surface Area dec for Photosynthesis

(c) less water → less metabolic Activity

Ex- Seed

11.10.4 Water

Even though water is one of the reactants in the light reaction, the effect of water as a factor is more through its effect on the plant, rather than directly on photosynthesis. Water stress causes the stomata to close hence reducing the CO_2 availability. Besides, water stress also makes leaves wilt, thus, reducing the surface area of the leaves and their metabolic activity as well.

DOPA -06

Q1 which is not Intrinsic factor which affect Rate of photosynthesis

(a) Internal CO_2 (b) External CO_2 (c) Age of leaf (d) Chloroplast number

Q2 Factor depend on genetic predisposition of plant

(a) Rate of photosynthesis (b) no. of stomata (c) light (d) temp.

Q3 Rate of photosynthesis depend on

(a) light wavelength (b) daylength (c) intensity (d) all

Q4 10% light is sufficient For

(a) optimum photosynthesis (b) Beyond which Rate not depend on light (c) After that (d) all other factor limiting

Q5 law of limiting Factor Given By

(a) Engleman (b) Blackman (c) Priestley (d) all

Q6 Water as Factor

(a) not affect Rate (b) Not limiting (c) Act through Plant (d) all

Q7 CO_2 conc. Above 380 ppm can be limiting For

(a) Maize (b) Sugarcane (c) Sorghum (d) Neem

Q9 Saturation of Green house plant occur at

(a) 360 ppm (b) 450 ppm (c) 380 ppm (d) all

Q10 temp can affect

(a) Light Rxn (b) Dark Rxn (c) Photosynthesis (d) all

MANTHAN NEET 2025 1.0 to 2.0

SANKALP NEET VEDANTU

Respiration in plants
lecture - 01

Botany

TARUN SIR

Topic 2-30

→ Introduction

→ Respiratory Substrate

→ Glycolysis

→ Aerobic Respiration - link Rxn
- Krebs cycle
- ETS

→ Anaerobic Respiration

→ ATP Balance sheet

→ Amphibolic pathway

→ RQ

Today's Goal

→ Introduction

→ Respiratory Substrate

Respiration in plants

Introduction → Breathing ⟶ O_2 uptake ⟶ Related to Energy (O_2 use Energy Produce)

Respiration → It is oxidation of Food → to produce Energy

Use of Energy → Daily life Activity (Food Absorption, transport of Substance
Movement
Nerve impulse transmission) &

Source of Energy → Oxidation of Food

Source of Food For Respiration

- Food is → Glucose

→ Two type of cells → (a) Autotrophic cell

Glucose → Oxidation → CO_2 + Energy (Photosynthesis)

Autotrophic cell → Food synthesis inside cell

(b) Heterotrophic cell →

Glucose → CO_2 (Oxidation)

→ In plants → two type cells → Leaf – Autotrophic cell → Food synthesis For themself & For others

Food transport occur in Form of Sucrose → From leaf cell (Autotrophic) to Root cell (Heterotrophic)

→ On Earth → Plants & Cyanobacteria — Are Autotroph ✓

→ In plants, not all cells are Autotrophic for Example – Root cells are Heterotrophic

→ Plant produce Glucose (Food) (organic) ⟶ three use (a) Oxidise For themself For Energy ✓
(b) Send plant part which are heterotrophic ✓ (Root cells)
(c) Store in Form of Starch → On which other Heterotroph Animal depends

→ Many Bacteria, all Fungi (Saprophytic), all Animals — Heterotrophic ✓

Q Which is common in (Leaf cell) Mesophyll cell & Fungi hyphe
(a) Nutrition (b) Oxidation of Food (c) Presence of pigment (d) all
(Chlorophyll)

Respiration - Basics

(a) It is oxidation of Food

(b) Stepwise oxidation — then only we can trap Energy

(c) It occur inside cell → Respiration is cellular Process

(Energy → Form inside Cell → So it is cellular Energy trap in Form of ATP

(d) It is catabolism (Breakdown of Food)

(e) location — Cytoplasm & Mitochondria
(Glycolysis) (Kreb cycle, Link Rxn)

(f) It is Exergonic (Energy Release)

Glucose → C-C-C-C-C-CHO
OH OH OH OH OH

C(OH) → CHO → COOH → CO_2
ε ε ε
→ ATP Form

(f) It is Enzymatic process

Q location of ATP Synthesis in cell
(a) Mitochondria (b) Cytoplasm
(c) Both (d) None

Q location of ATP synthesis in all cells
(a) (b) Cytoplasm (c) (d)

Q Oxidation of Food not occur in | Respiratory Enzyme Absent in
(a) PPLO (b) Archaebacteria (c) HIV (d) all

Q Respiration not involve
(a) oxidation of organic Food
(b) Cellular Energy produce
(c) No Energy Release in Form of Heat
(d) occur in cytoplasm & Mitochondria

Q Which is true
S-I → all living organism breathe ✗
S-II - all living organism Require O_2 ✗ (Anaerobic)
S-III - all living organism show Respiration ✓

All of us breathe to live, but why is breathing so essential to life? What happens when we breathe? Also, do all living organisms, including plants and microbes breathe? If so, how?

Breathing → O_2 → Enter into cell → Respiration

Q All organism like plants, microbes Animals show

(a) Photosynthesis (b) Breathing (c) Respiration (d) all

All living organisms need energy for carrying out daily life activities, be it absorption, transport, movement, reproduction or even breathing. Where does all this energy come from? We know we eat food for energy – but how is this energy taken from food? How is this energy utilised? Do all foods give the same amount of energy? Do plants 'eat'? Where do plants get their energy from? And micro-organisms – for their energy requirements, do they eat 'food'?

S-I Oxidation of Food Give Energy

S-II Oxidation of all type of Food give same Amount of Energy

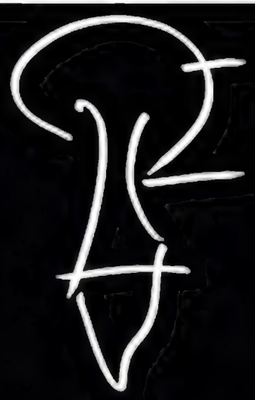
All the energy required for 'life' processes is obtained by oxidation of some macromolecules that we call 'food'. Only green plants and cyanobacteria can prepare their own food; by the process of photosynthesis they trap light energy and convert it into chemical energy that is stored in the bonds of carbohydrates like glucose, sucrose and starch. We must

Food oxidation

Q Light Energy convert into chemical Energy
(a) Plants (b) Cyanobacteria (c) Some protist
(d) all

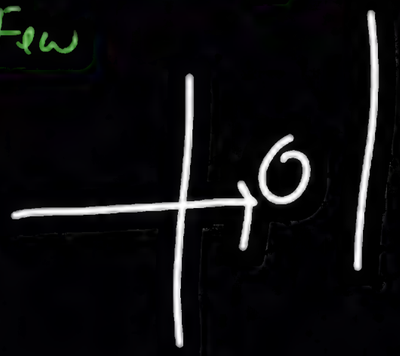
Q Food is
(a) Macromolecule (b) Micromolecule

the bonds of carbohydrates like glucose, sucrose and starch. We must remember that in green plants too not all cells, tissues and organs photosynthesise; only cells containing chloroplasts, that are most often located in the superficial layers, carry out photosynthesis. Hence, even in green plants all other organs, tissues and cells that are non-green, need food for oxidation. Hence, food has to be translocated to all non-green parts. Animals are heterotrophic, i.e., they obtain food from plants



leaf cell – most → Superficial

stem cell → Few



Q Food is need to be translocated
(a) Green part
(b) non Green part
(c) all part
(d) no part

directly (herbivores) or indirectly (carnivores). Saprophytes like fungi are dependent on dead and decaying matter. What is important to recognise is that ultimately all the food that is respired for life processes comes from photosynthesis. This chapter deals with **cellular respiration** or the mechanism of breakdown of food materials within the cell to release energy, and the trapping of this energy for synthesis of ATP.

Q All Food For oxidation Come From
(a) Plants
(b) Photosynthesis
(c) Green plants
(d) none

Respiratory Substrate

→ Inside cell → Oxidation of Food occur

– all carbon compound which Undergo Respiratim is Respiratory Substrate

→ Normally Carbohydrate is Respiratory Substrate

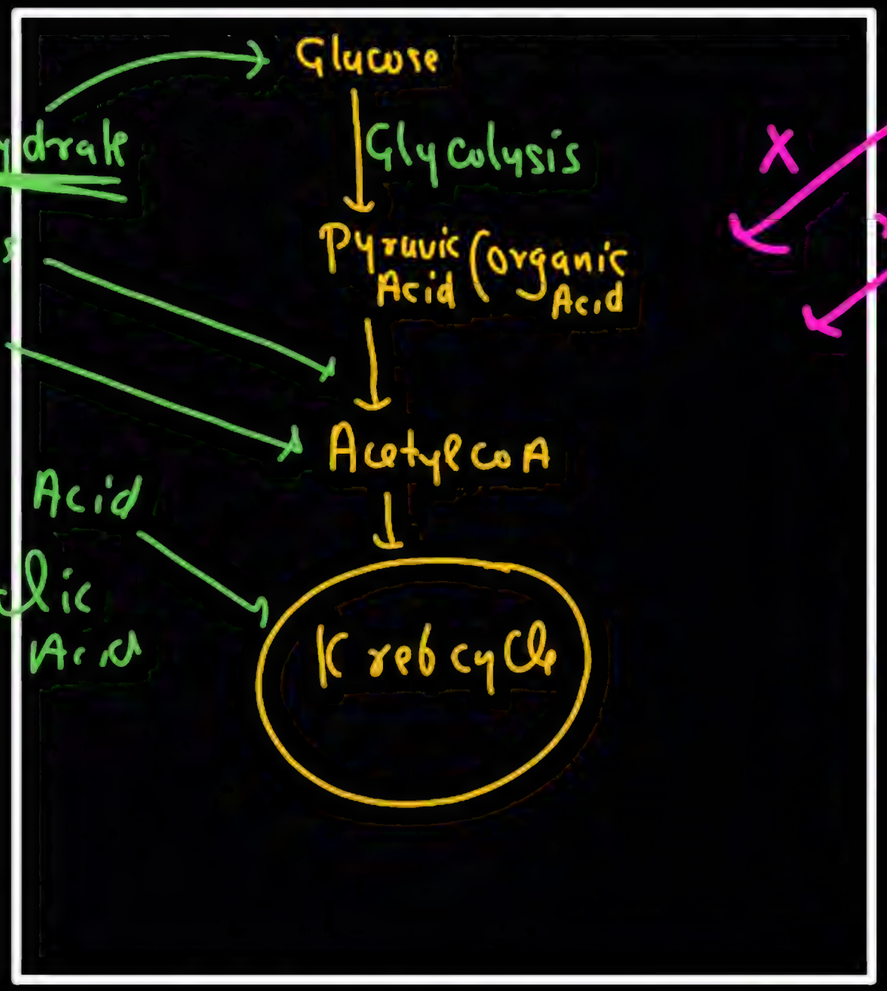
→ But Amino acids, Organic Acid Fat can also be used

not use as Respiratory Substrate → Minerals, Vitamins, H_2O, Hormones →

Feature of Respivatory Substrate

① organic (C–C Bond present)

② Inside cell Reactim present to use that Substrate



Vitamins ✗

Mineral ✗

(not Able to Enter in Respiratory Chain)

Thiamin - Vit-B_1

Thymine → Nitrogenous B_{ase}

Q Which is not Respiratory Substrate

(a) Glucose (b) Alanine (Amino Acid

(c) Palmitic Acid (Fatty Acid) (d) ~~Thiamine~~ (Vitamin-B)

Q Which is Respiratory Substrate

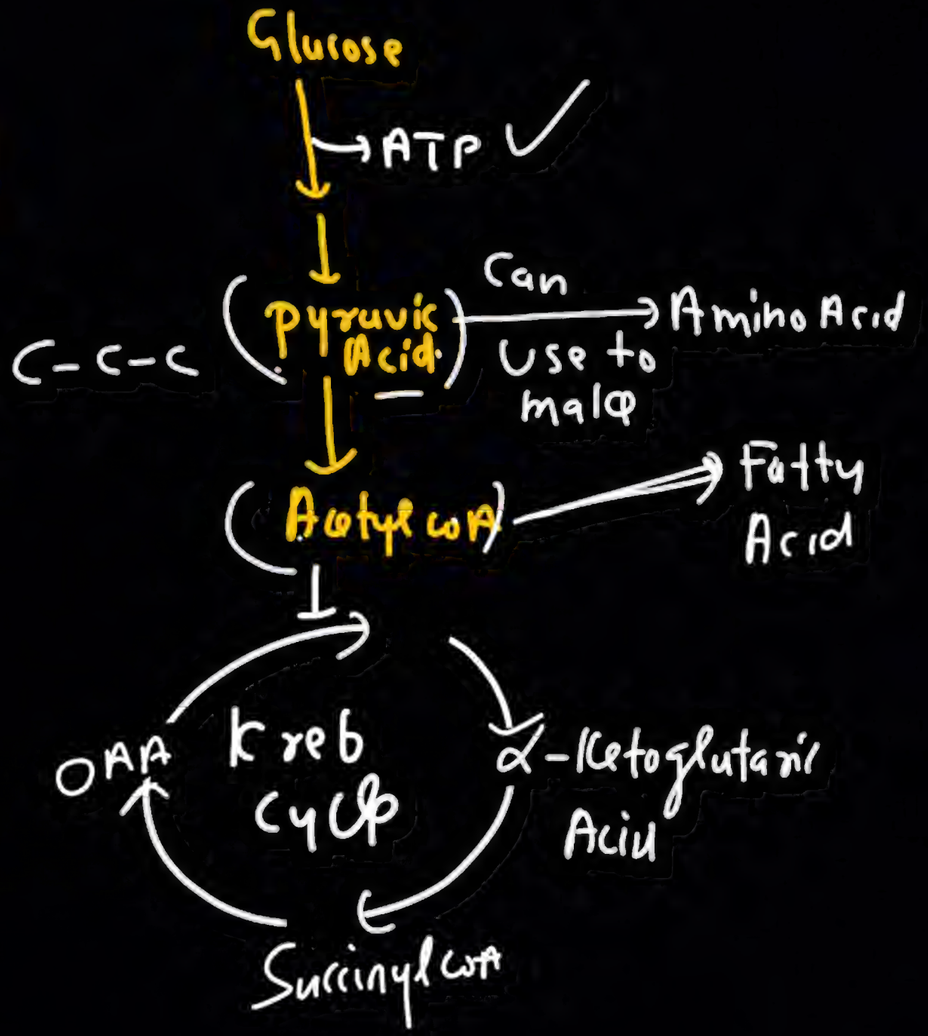
(a) Iron (b) Insulin (c) ~~Sucrose~~ (d) Vit-C

Role of Respiration

(a) Produce Energy ✓ (two Form - ATP, NADH)

(b) Produce compound / intermediate

During Respiration use in Biosynthesis of some other Compound



DOPA - 01

Q1

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Respiration in plants
lecture - 02

Botany

TARUN SIR

Topic 2-30

→ Introduction

→ Respiratory Substrate

→ Glycolysis

→ Aerobic Respiration - link Rxn
- Krebs cycle
- ETS

→ Anaerobic Respiration

→ ATP Balance sheet

→ Amphibolic pathway

→ RQ

Today's Goal

→ Introduction

→ Respiratory Substrate

Plant Breathe or not

→ Plant not Breath → But Require O_2 → For Respiration and Oxidation of Food

→ Plants lack → special organs like lungs for gaseous Exchange]

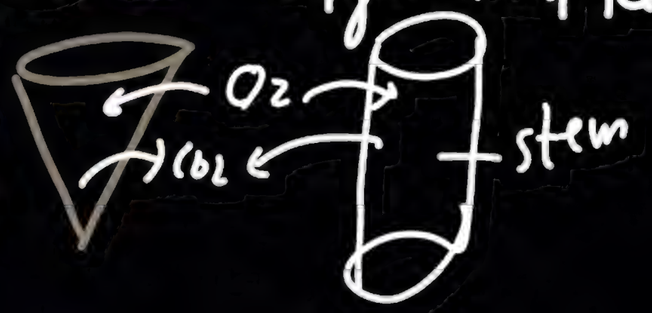
Why plant not Require special organs

[① Plant Require less Energy → Comparison to Animals (Very less O_2 Require)

(Root, stem & leaf – Respire with lesser Rate)

less oxygen Require

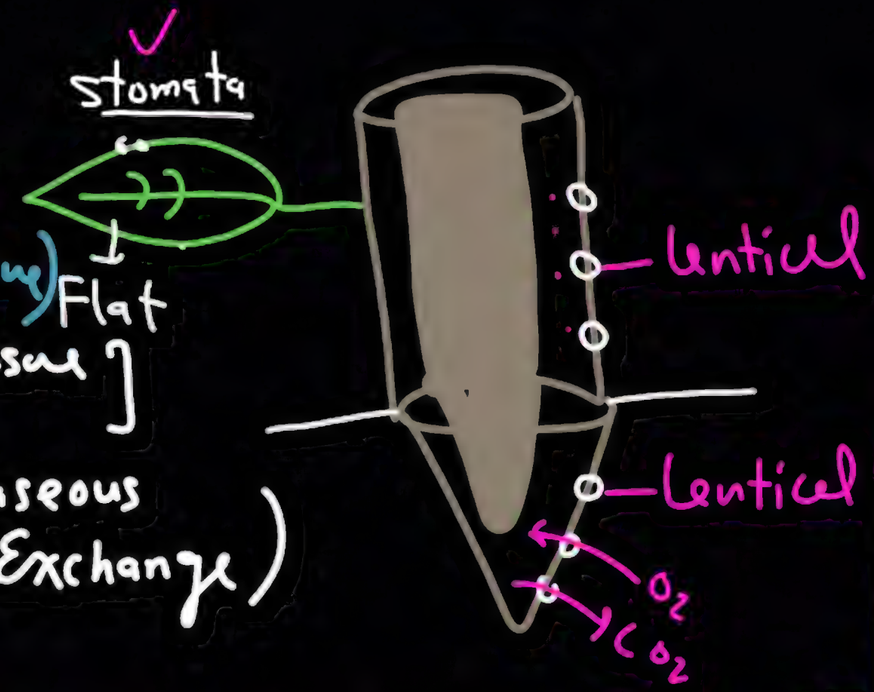
[② All oxygen they Require → Occur From Surface of plant part

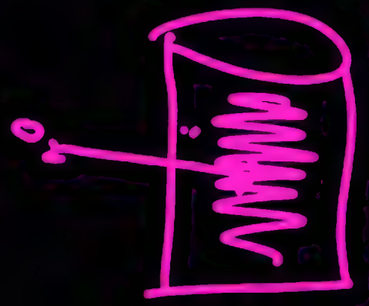


leaf → Maximum gaseous Exchange Comparison to Root and stem → leaf can do this with help of Stomata

(3) Gas Diffusion For lesser distance (inside of stem & Root - dead tissue)

(Reason – Stem, Root → deep tissue Dead
– stem & Root → lenticel gaseous Exchange)



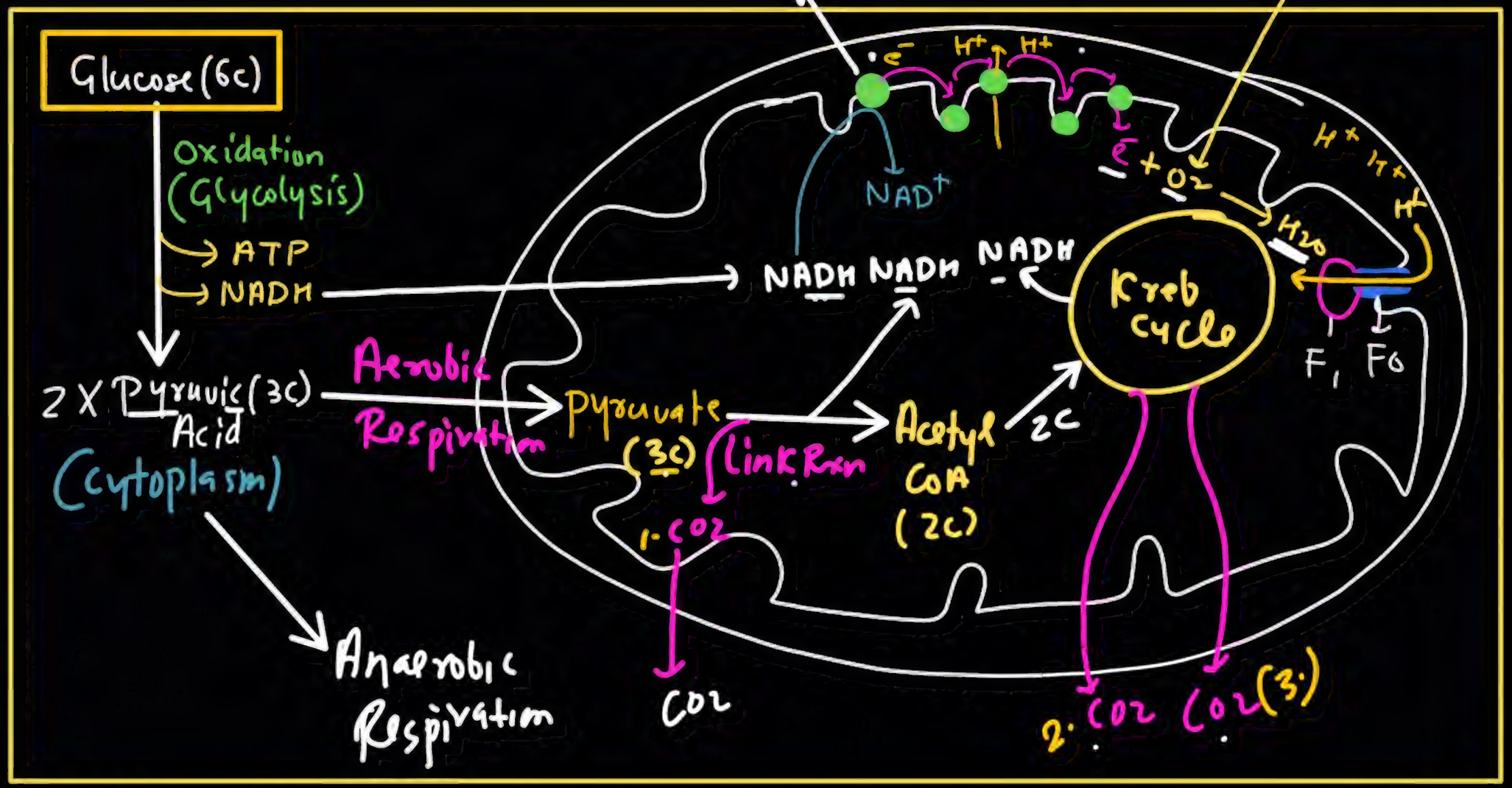


Q Plant not perform
(a) Respiration (b) Breathing (c) Gaseous Exchange (d) all

Q On plant gaseous Exchange occur By
(a) Stomata (b) lenticel (c) Both (d) none

Q Plant Not Require Blood
(a) Gas Diffusion occur For longer Distance
(b) deep tissue dead, and at Surface Gaseous Exchange Easily occur

Scheme of Respiration



→ Location of Respiration → Cytoplasm + Mitochondria → Link Rxn, Kreb cycle

→ Respiration → $C_6H_{12}O_6 + O_2 \longrightarrow 6CO_2 + 6H_2O$ → Produce ETS

(Glucose oxidation ⟶ O_2 use (use in Mitochondria in ETS where it combine with $\bar{e}$ and H^+ to give water)

→ Water which Form is Metabolic water

→ Such Respiration is Aerobic Respiration

→ If O_2 Absent / O_2 not use By - Methanogen → Energy not From in Mitochondria

(Anaerobic condition)

→ In Aerobic & Anaerobic organism → Glycolysis common

→ Early Earth → No oxygen → Anaerobic Respiration Evolve

When O_2 Form then Aerobic Respiration

Glycolysis

Important points :- Meaning - Glycos (Sugar) + lysis (Breakdown)

(2) Scheme/steps Discover By three scientist (Glycolysis → EMP Pathway)
E - Embedon
M - Mayerhof
P - Parnas

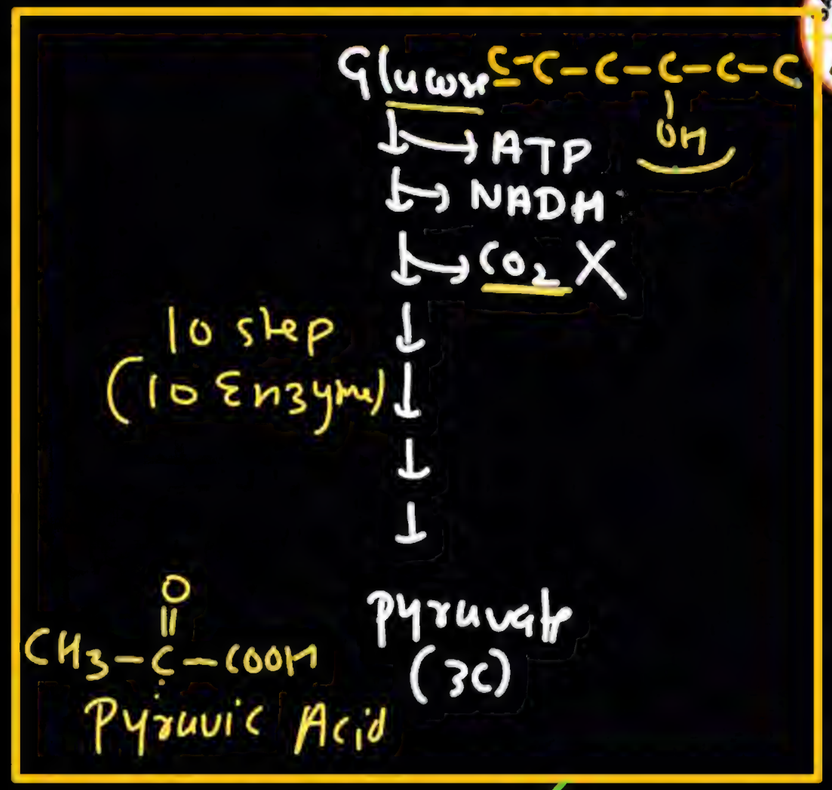
(3) total 10 step / 10 Enzyme → Present in Cytoplasm

(4) Glucose - stepwise oxidation

(5) No CO_2 From (Partial oxidation)

(6) O_2 not use

(7) Energy From → ATP, NADH



Glucose → 6 CO_2 (Complete oxidation)

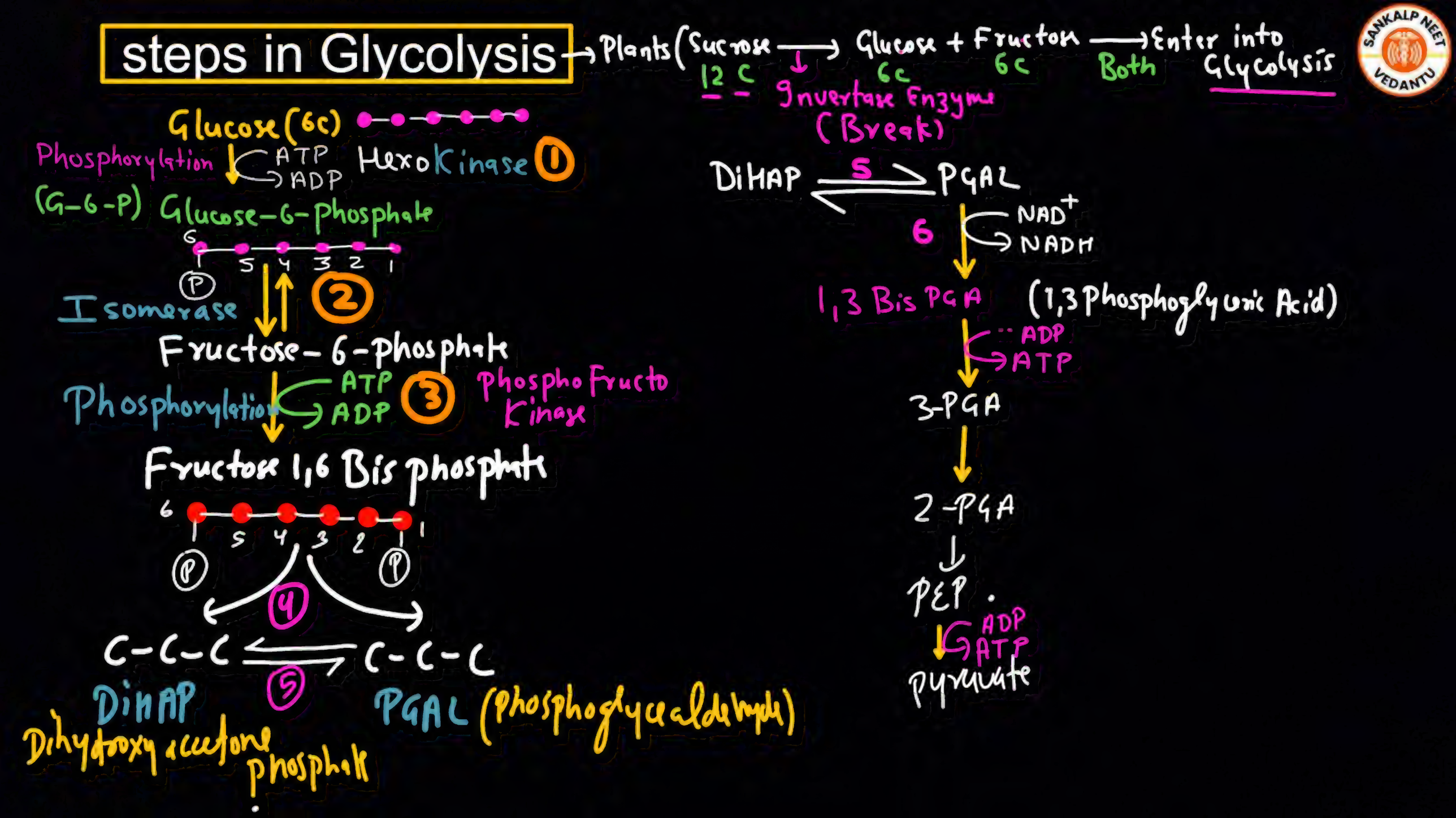
Partial

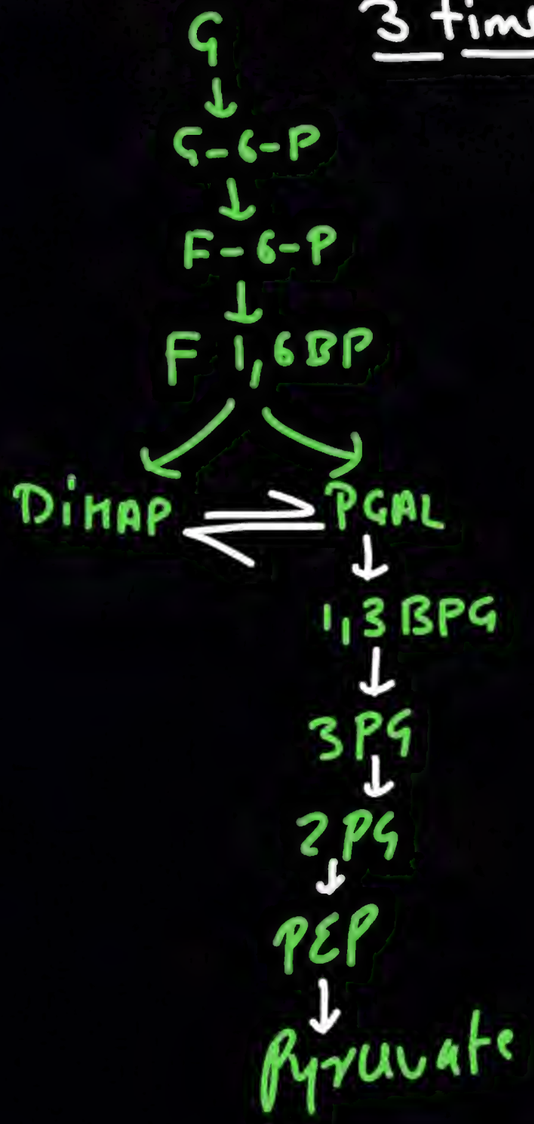
→ 2 CO_2 + 2 Ethanol (Incomplete oxidation)

→ Pyruvate X 2 (3C) = 6C

steps in Glycolysis

Plants (Sucrose → Glucose + Fructon → Enter into Glycolysis)
12 C — 6C — 6C — Both
↓ Invertase Enzyme (Break)




3 time
G
G-6-P
F-6-P
F 1,6 BP
DHAP
PGAL
1,3 BPG
3PG
2PG
PEP
Pyruvate

DOPA – 01

Q1 Which occur in all cells
(a) Aerobic Respiration (b) Anaerobic Respiration (c) Respiration (d) Breathing

Q2 S-I – Plants are Autotrophic
S-II In plants all cells are Autotrophic

Q3 Autotrophic plants have
(a) all cells Autotrophic (b) Heterotrophic cells are saprophytic (c) Autotrophic cells in deep layer (d) Respiration occur in Autotrophic cells

Q4 Respiration is
(a) Catabolic process (b) Oxidation in Step (c) No Energy loss in Heat (d) Cellular process

Q5 Cellular Energy or ATP Produced in
(a) Cytoplasm (b) Mitochondria (c) Both (d) none

Q6 Common in Aerobic & Anaerobic organism

(a) O_2 use (b) Glycolysis (c) CO_2 produce in mitochondria (d) Evolve at same time

Q7 Respiratory Substrate

(a) organic (b) Use in Respiration (c) present inside cell (d) all

Q8 Not Respiratory Substrate

(a) Fructose (b) Alanine (c) Ascorbic Acid (d) Palmitic Acid

Q9 S-I → Plants show gaseous Exchange & Aerobic Respiration

S-II In plant stem, deep Part Recieve gas By Diffusion

Q10 Not true About Glycolysis

(a) Cytoplasm Location (b) Partial oxidation (c) ATP Form (d) CO_2 Form

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Respiration in plants

lecture - 03

Botany

TARUN SIR

Topic 2-30

→ Introduction

→ Respiratory Substrate

→ Glycolysis

→ Aerobic Respiration
- link Rxn
- Kreb cycle
- ETS

→ Anaerobic Respiration

→ ATP Balance sheet

→ Amphibolic pathway

→ RQ

cell theory

Today's Goal

→ Introduction

→ Respiratory Substrate

Glycolysis

Important points :- Meaning - Glycos (Sugar) + lysis (Breakdown)

(2) Scheme/steps Discover By three Scientist (Glycolysis → EMP Pathway)
E - Embedon
M - Mayerhof
P - Parnas

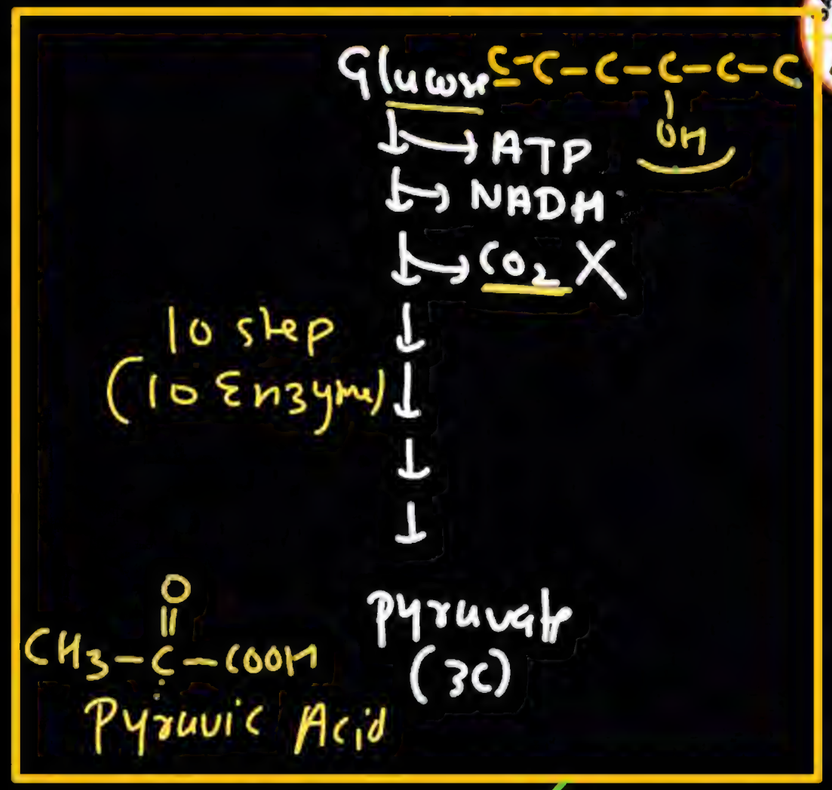
(3) total 10 step / 10 Enzyme → Present in Cytoplasm

(4) Glucose - stepwise oxidation

(5) No CO_2 From (Partial oxidation)

(6) O_2 not use

(7) Energy From → ATP, NADH



Glucose → 6 CO_2 (Complete oxidation)

Glucose → 2 CO_2 + 2 Ethanol (Incomplete oxidation)

Partial

Pyruvate X 2
(3C) = 6C

steps in Glycolysis

Plants (Sucrose (12 C) → Glucose (6C) + Fructon (6C) → Enter into Glycolysis (Both)

↓ Invertase Enzyme (Break)

Glucose (6C)

Phosphorylation (G-6-P) ← ATP / ADP — Hexokinase (1)

Glucose-6-phosphate

Isomerase (2)

Fructose-6-phosphate

Phosphorylation ← ATP / ADP (3) — Phospho Fructo Kinase

Fructose 1,6 Bis phosphate

(4)

C-C-C ⇌ C-C-C (5)

DiHAP (Dihydroxy acetone phosphate) ⇌ PGAL (Phosphoglyceraldehyde)

DiHAP ⇌ PGAL (5)

PGAL (6) ← NAD+ / NADH

1,3 Bis PGA (1,3 Phosphoglyceric Acid)

ADP / ATP

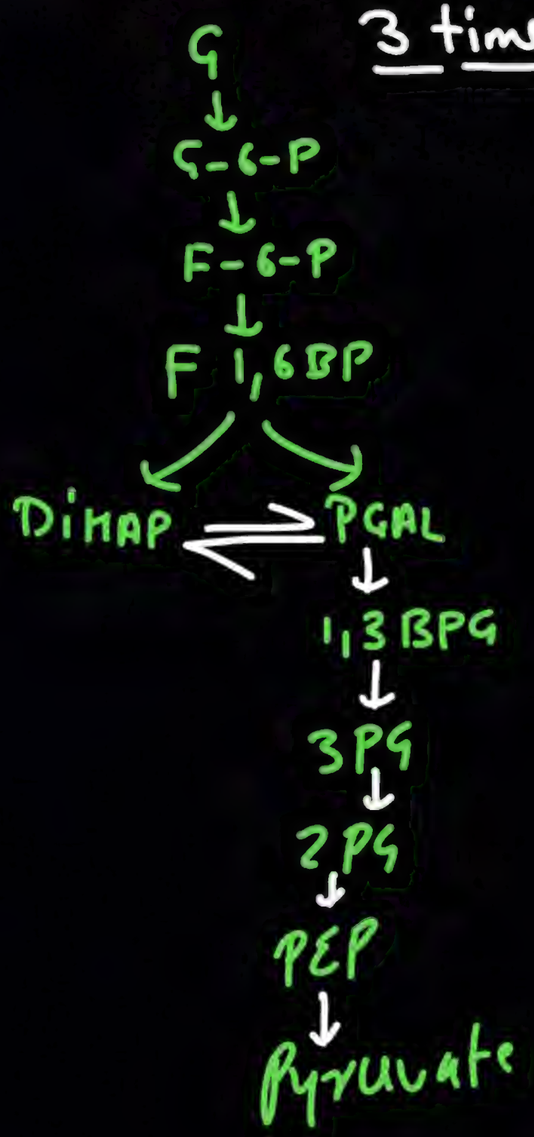
3-PGA

2-PGA

PEP

ADP / ATP

Pyruvate


3 time
G
G-6-P
F-6-P
F 1,6 BP
DHAP
PGAL
1,3 BPG
3PG
2PG
PEP
Pyruvate

DOPA – 01

Q1 Which occur in all cells
(a) Aerobic Respiration (b) Anaerobic Respiration (c) Respiration (d) Breathing

Q2 S-I – Plants are Autotrophic ✓
S-II In plants all cells are Autotrophic ✗

Q3 Autotrophic plants have
(a) all cells Autotrophic (b) Heterotrophic cells are saprophytic ✗ (c) Autotrophic cells in deep layer ✗ (d) Respiration occur in Autotrophic cells

Q4 Respiration is all Except
(a) Catabolic process (b) Oxidation in Step (c) No Energy loss in Heat (d) Cellular process

Q5 Cellular Energy or ATP Produced in
(a) Cytoplasm (b) Mitochondria (c) Both (d) none

Q6 Common in Aerobic & Anaerobic organism

(a) O_2 use (b) Glycolysis (c) CO_2 produce in mitochondria (d) CO_2 Evolve at same time

Q7 Respiratory Substrate

(a) organic (b) Use in Respiration (c) present inside cell (d) all

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(a) Fructose (b) Alanine (c) Ascorbic Acid (d) Palmitic Acid

unit-c

Q9 S-I → Plants show gaseous Exchange & Aerobic Respiration ✓

S-II In plant stem, deep Part Recieve gas By Diffusion ✗

Q10 Not true About Glycolysis

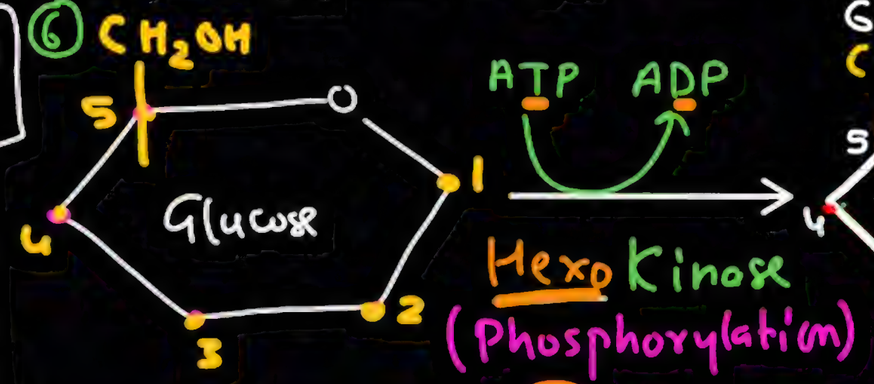
(a) Cytoplasm Location (b) Partial oxidation (c) ATP Form (d) CO_2 Form

Explanation

→ It is partial oxidation of Glucose

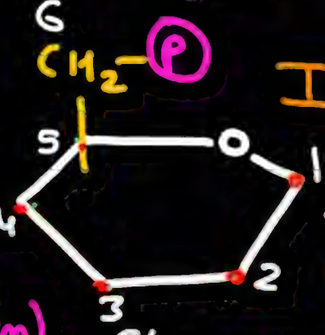
→ Glycolysis two phase → ① Energy investing phase ② Energy produce store in form ATP

Glucose 6C → ATP ADP → 6C → Glucose-6-P → Fructose-6-P → ATP ADP → Fructose 1,6 BP



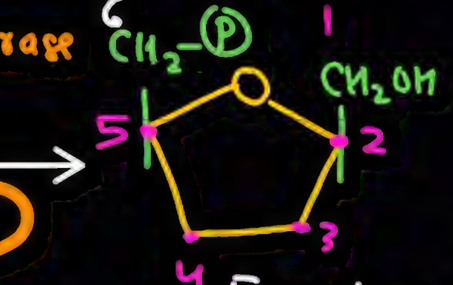
ATP ADP

Hexo Kinase (Phosphorylation) ①



Glucose-6-P

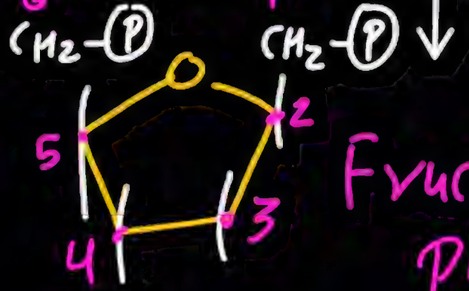
Isomerase ②



Fructose-6-phosphate

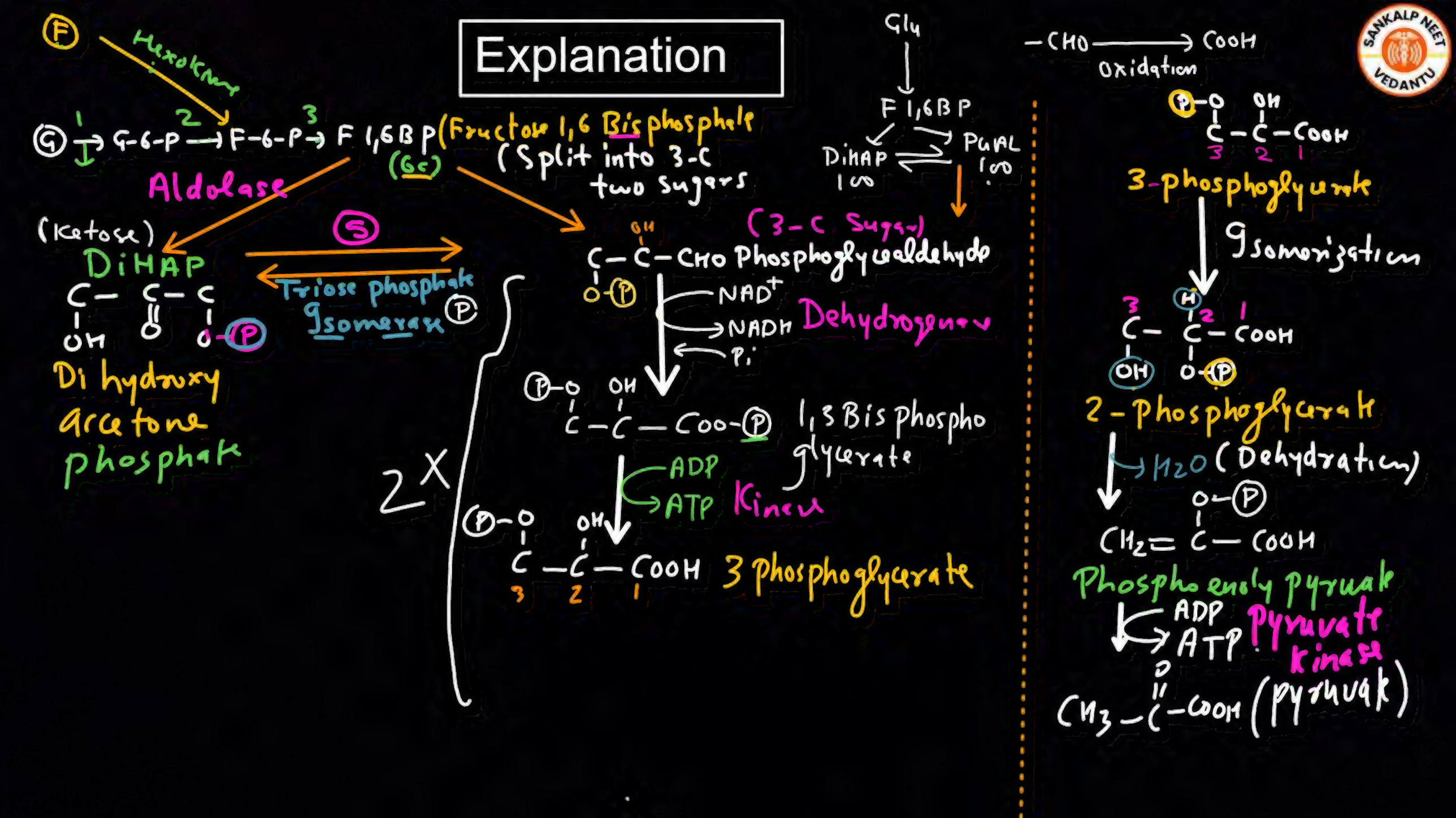
Phospho Fructo Kinase

ATP → ADP ③

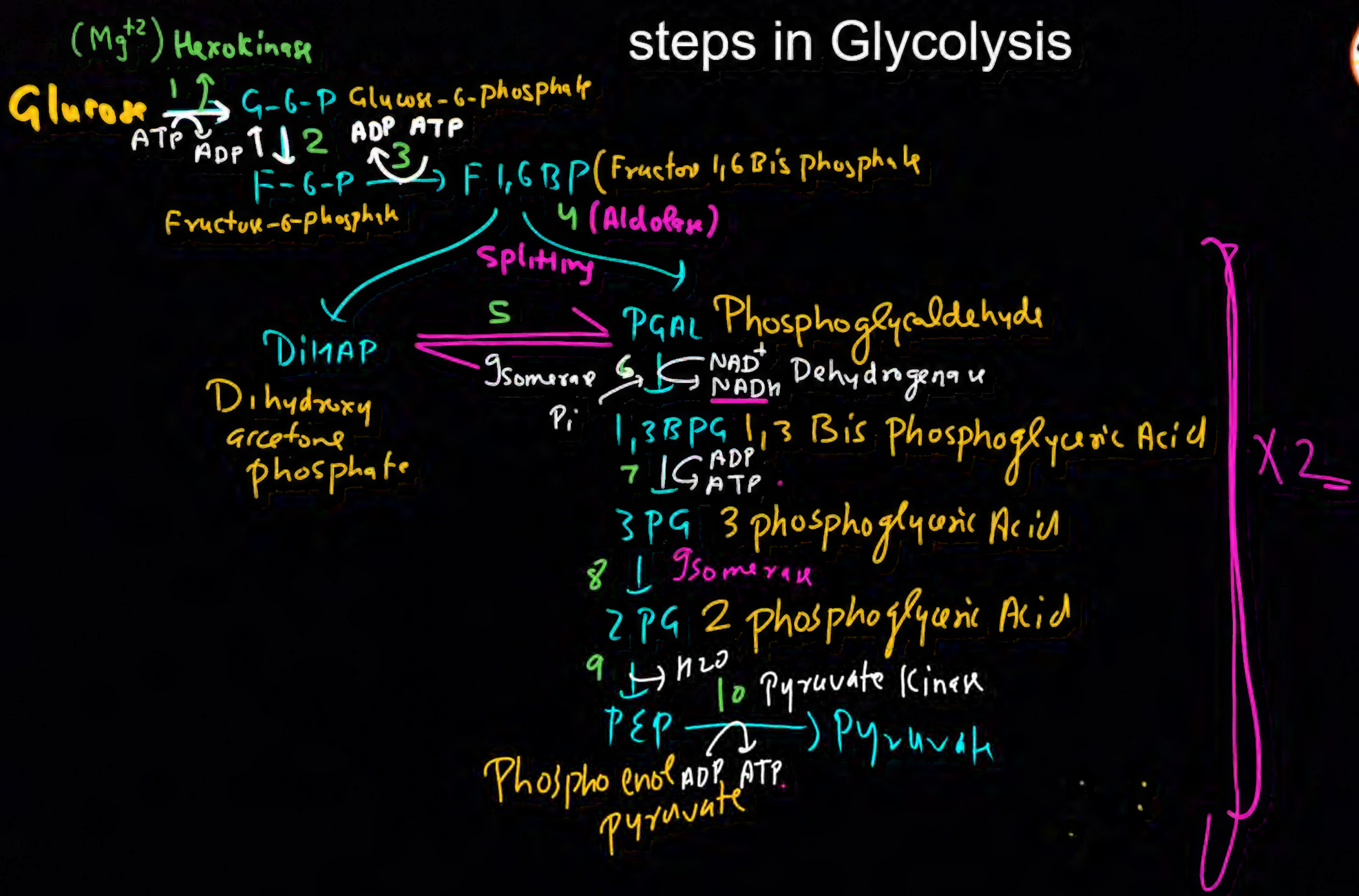


Fructose 1,6 Bis phosphate

Explanation



steps in Glycolysis



Important observation - Glycolysis

(a) Sugar Enter in Glycolysis → Glucose & Fructose

(b) Fructose Enter in glycolysis no. of steps → 9 step

(c) Steps use ATP in Glycolysis → 1st and 3rd

(d) Step produce ATP → 7^{th} & 10^{th}

(e) Step produce NADH → 6^{th}

(f) Irreversible step in Glycolysis → 1, 3, 10

(g) Important Enzymes — Hexokinase
→ Pyruvate Kinase

(h) 3-C sugars in Glycolysis → DHAP, PGAL

(i) Final product is Acid or Sugar — Acid (Pyruvic Acid)

(Net Gain of ATP)

- No. of ATP in Glycolysis] 2 ATP

- No. of ATP in Aerobic Glycolysis] 8 ATP

→ No. of ATP in Anaerobic Glycolysis] 2 ATP

Product in Glycolysis	2 NADH 2 ATP 2 pyruvate

2 ATP - Direct → Substrate level Phosphorylation

2 NADH → 6 ATP → in mitochondria

Pyruvate (2 molecule)

Direct ATP → SLP

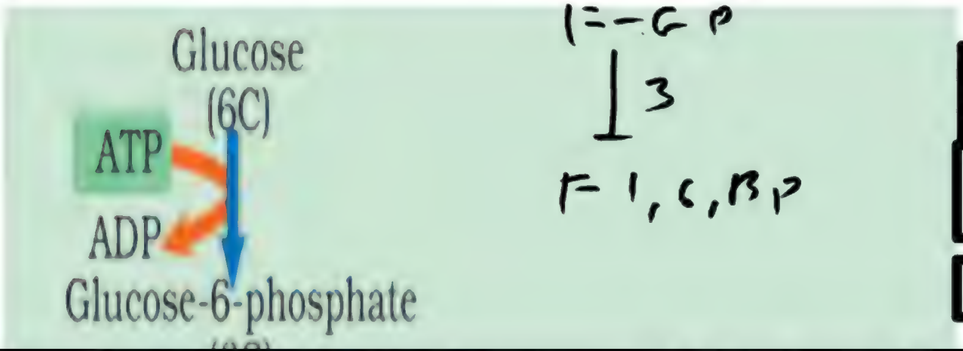
[1,3BPG → (ATP) → 3PG
PEP → (ATP) → Pyruvate]

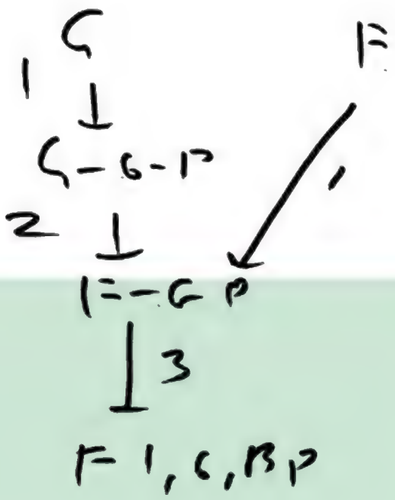
Substrate Level Phosphorylation

Pyruvate = 2 ✓
ATP = 2 ✓
NADH = 12

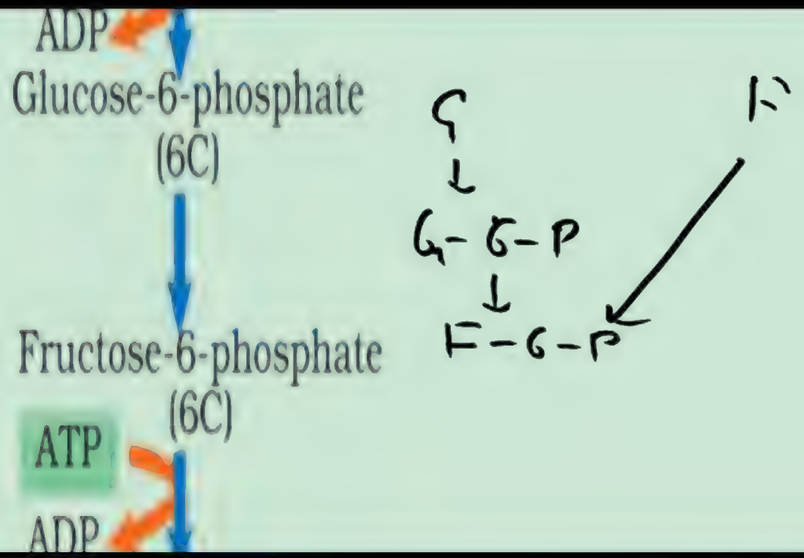
(1 NADH → 3ATP → in mitochondria)
(Aerobic Respiration

The term glycolysis has originated from the Greek words, *glycos* for sugar, and *lysis* for splitting. The scheme of glycolysis was given by Gustav Embden, Otto Meyerhof and J. Parnas, and is often referred to as the EMP pathway. In anaerobic organisms, it is the only process in respiration. Glycolysis occurs in the cytoplasm of the cell and is present in all living organisms. In this process, glucose undergoes partial oxidation to form two molecules of pyruvic acid. In plants, this glucose is derived from sucrose, which is the end product of photosynthesis, or from storage

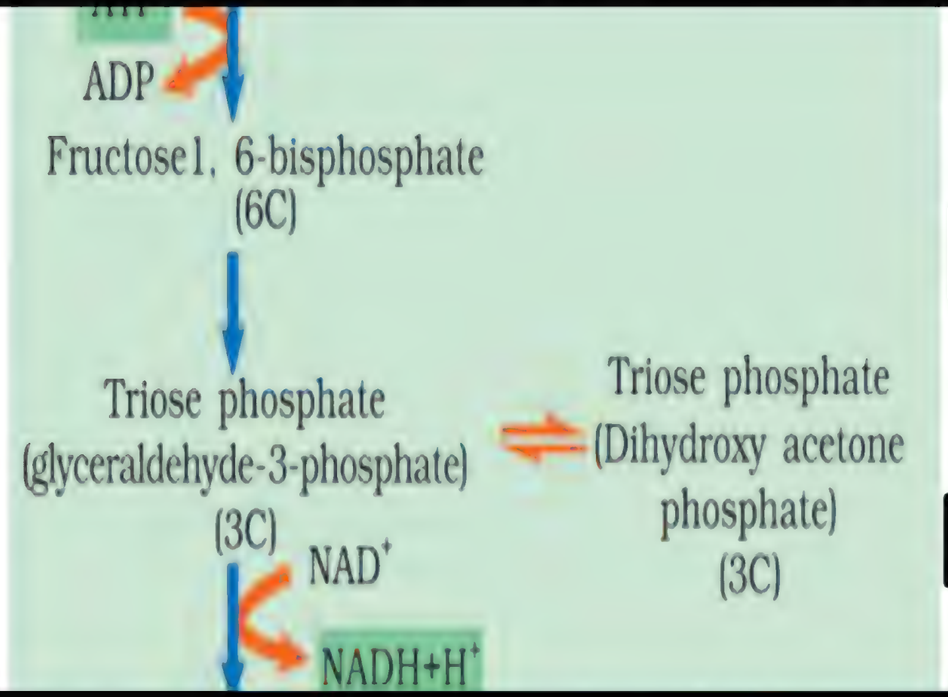




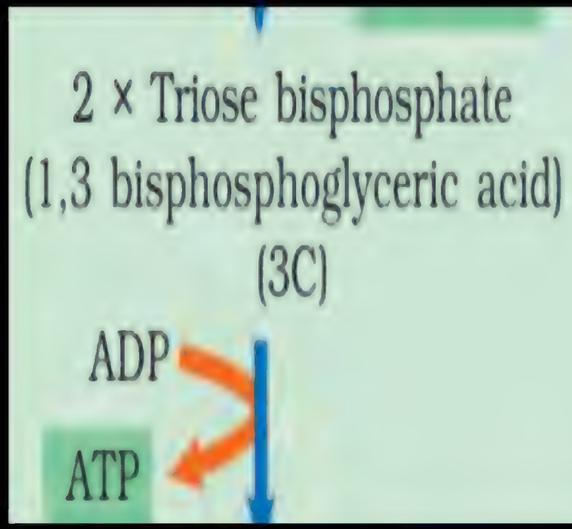
carbohydrates Sucrose is converted into glucose and fructose by the enzyme invertase and these two monosaccharides readily enter the glycolytic pathway. Glucose and fructose are phosphorylated to give rise to glucose-6-phosphate by the activity of the enzyme hexokinase. This phosphorylated form of



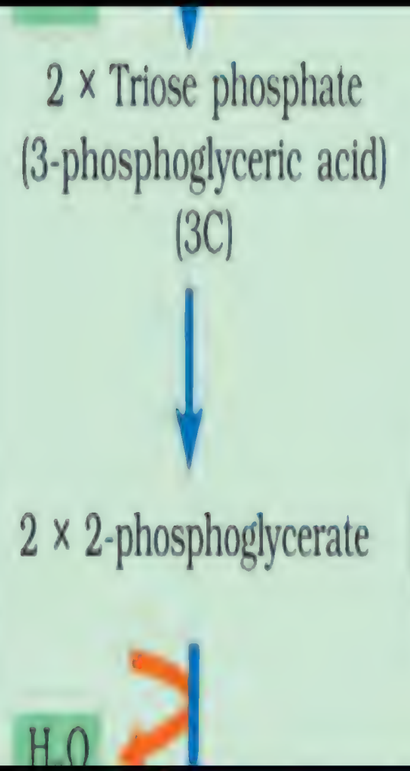
hexokinase. This phosphorylated form of glucose then isomerises to produce fructose-6-phosphate. Subsequent steps of metabolism of glucose and fructose are same. The various steps of glycolysis are depicted in Figure 12.1.



steps of glycolysis are depicted in Figure 12.1. In glycolysis, a chain of ten reactions under the control of different enzymes, takes place to produce pyruvate from glucose. While studying the steps of glycolysis, please note the steps at which utilisation or synthesis of ATP or (in this case) NADH + H^+ take place.



ATP is utilised at two steps: first in the conversion of glucose into glucose 6-phosphate and second in the conversion of fructose 6-phosphate to fructose 1, 6-bisphosphate.



1,3 BPGA

The fructose 1, 6-bisphosphate is split into dihydroxyacetone phosphate and 3-phosphoglyceraldehyde (PGAL). We find that there is one step where NADH + H^+ is formed from NAD^+; this is when 3-phosphoglyceraldehyde (PGAL) is converted to 1, 3-bisphosphoglycerate (BPGA). Two

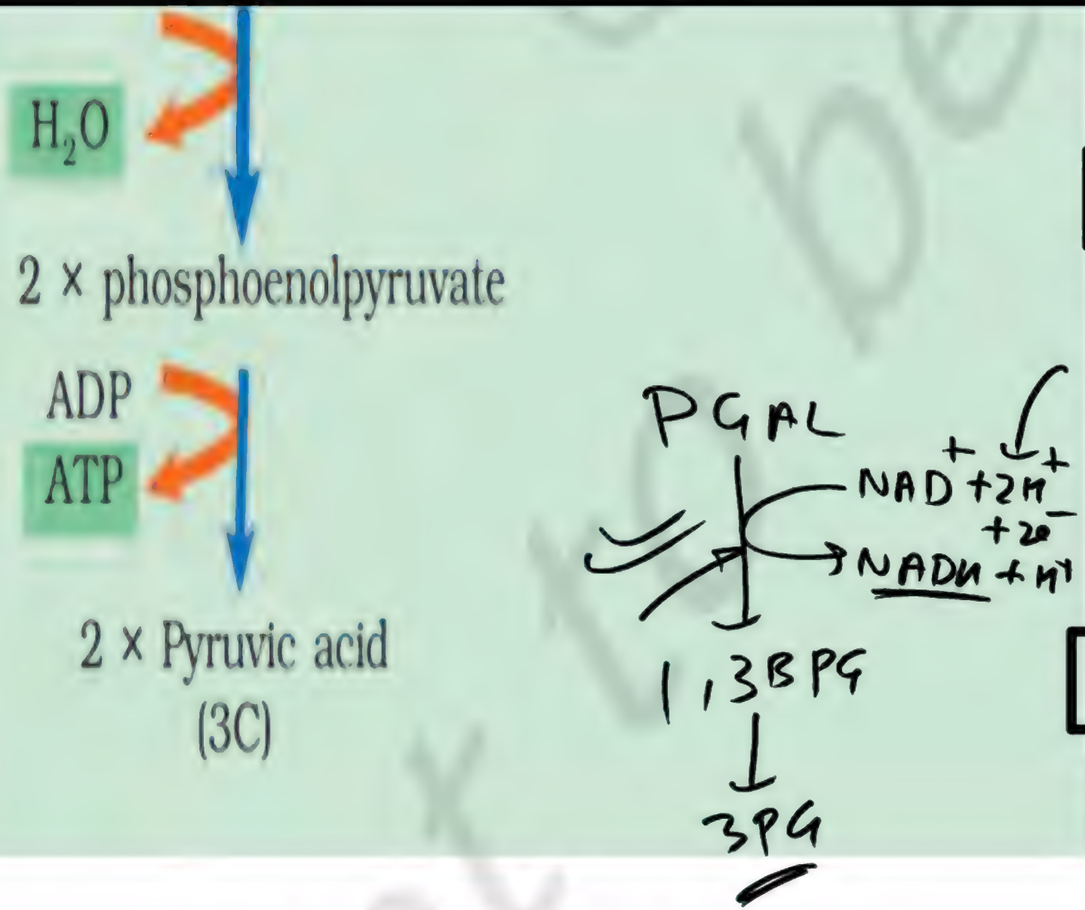
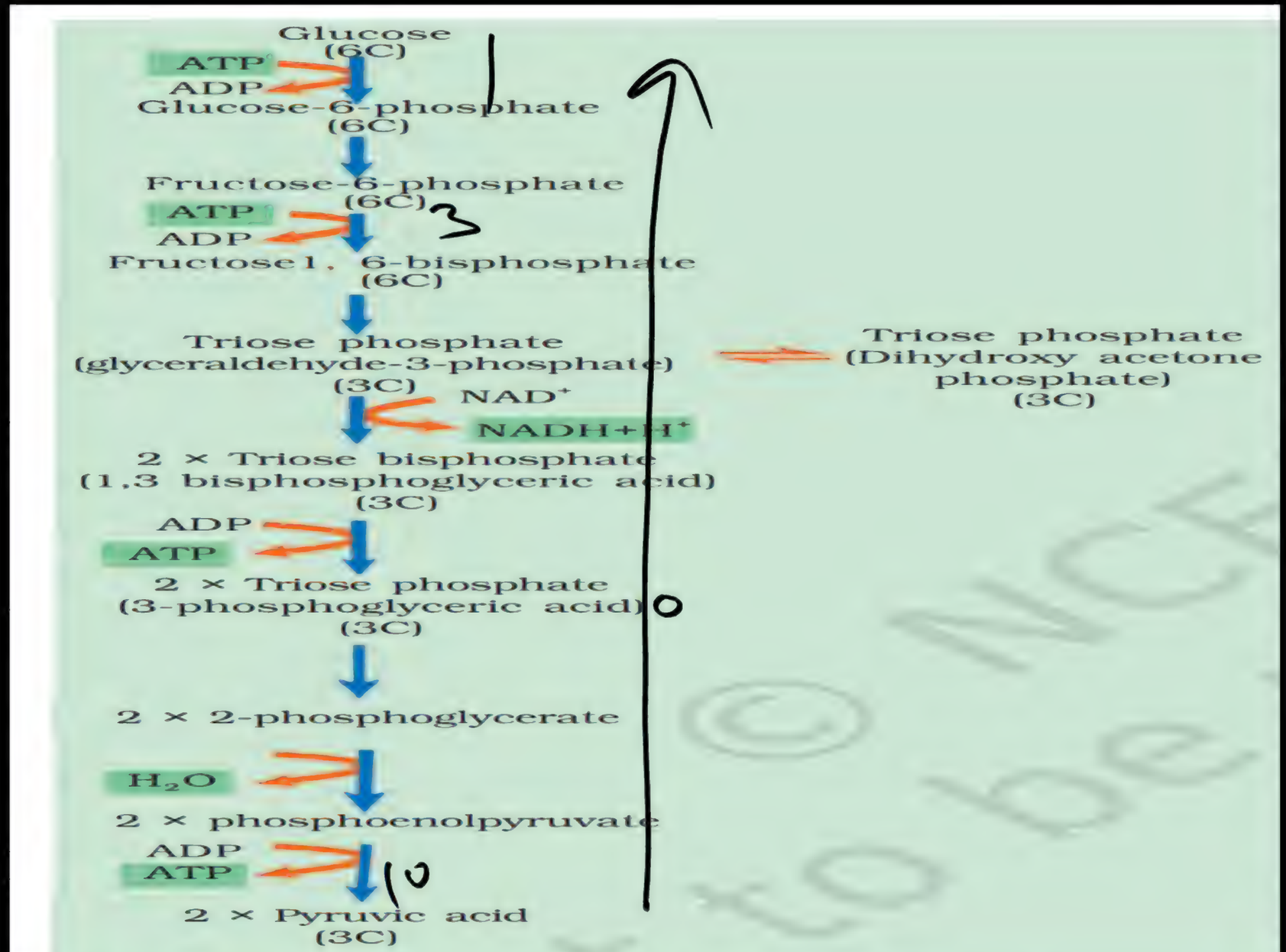


Figure 12.1 Steps of glycolysis

to 1, 3-bisphosphoglycerate (BPGA). Two redox-equivalents are removed (in the form of two hydrogen atoms) from PGAL and transferred to a molecule of NAD^+. PGAL is oxidised and with inorganic phosphate to get converted into BPGA. The conversion of BPGA to 3-phosphoglyceric acid (PGA), is also an energy yielding process; this energy is trapped by the formation of ATP. Another ATP is synthesised during the conversion of PEP to pyruvic acid.


Glucose
(6C)
ATP
ADP
Glucose-6-phosphate
(6C)
Fructose-6-phosphate
(6C)
ATP
ADP
Fructose 1, 6-bisphosphate
(6C)
Triose phosphate
(glyceraldehyde-3-phosphate)
(3C)
NAD+
NADH+H+
2 × Triose bisphosphate
(1,3 bisphosphoglyceric acid)
(3C)
ADP
ATP
2 × Triose phosphate
(3-phosphoglyceric acid)
(3C)
2 × 2-phosphoglycerate
H2O
2 × phosphoenolpyruvate
ADP
ATP
2 × Pyruvic acid
(3C)
Triose phosphate
(Dihydroxy acetone
phosphate)
(3C)

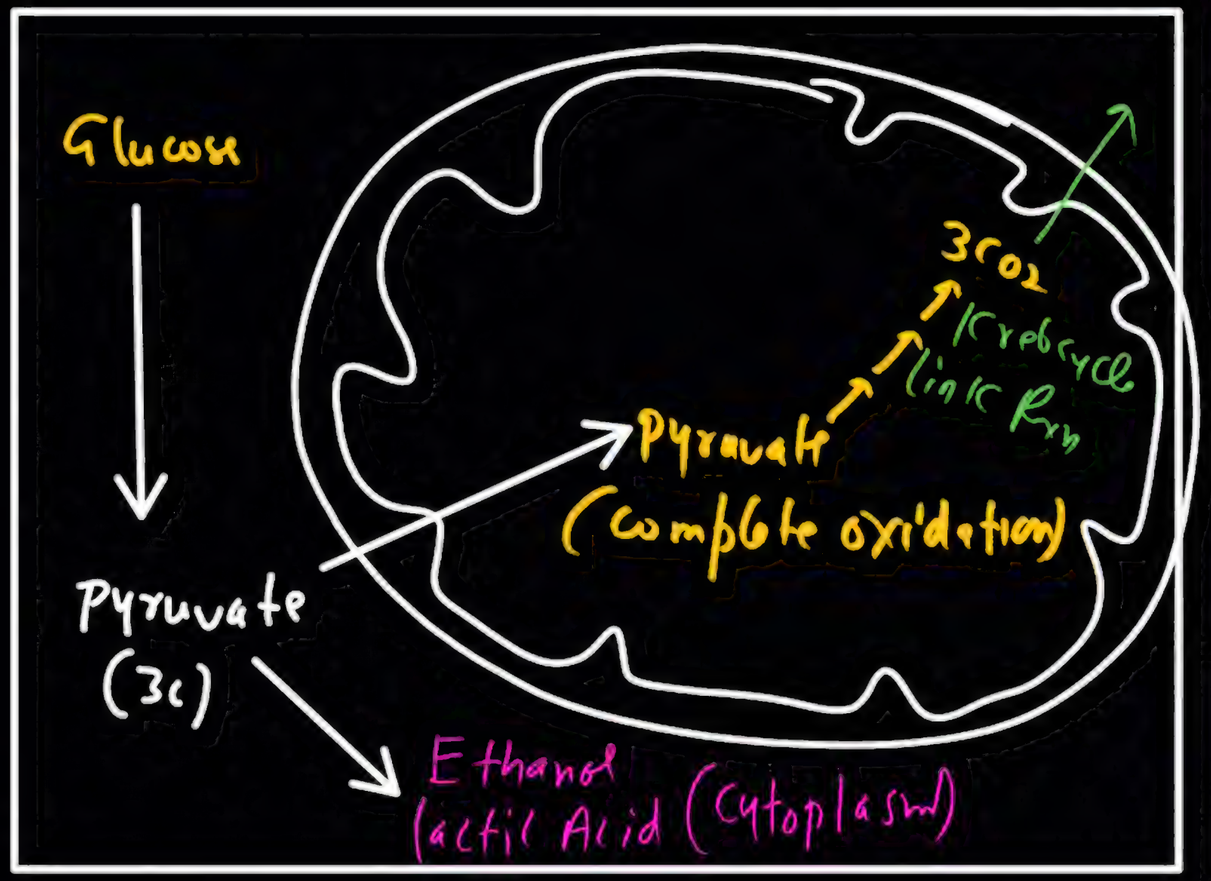
There are three major ways in which different cells handle pyruvic acid produced by glycolysis. These are lactic acid fermentation, alcoholic fermentation and aerobic respiration. Fermentation takes place under anaerobic conditions in many prokaryotes and unicellular eukaryotes. For the complete oxidation of glucose to CO_2 and H_2O however, organisms adopt Krebs' cycle which is also called as aerobic respiration. This requires O_2 supply.

Future ← # Fate of pyruvic Acid

- Glycolysis occur in all cells
- Pyruvate Further Oxidation depend on
  (a) type of cells (b) Presence or Absence of O_2 (Condition)

I Aerobic Fate — In Any cell
Mitochondria present, O_2 present
(Pyruvate → Aerobic Respiration)

II Anaerobic Fate → In Absence of O_2
(Mitochondria Absent or Both)



DOPA-02

Q1 3-C Sugar Form in Glycolysis
(a) DiHAP (b) PGAL (c) Both (d) none

Q2 3-C Sugar oxidised in Glycolysis
(a) DiHAP (b) PGAL (c) Both (d) none

Q3 No. of NADH form in Glycolysis During Synthesis of two pyruvate
(a) two (b) three (c) Four (d) Five

Q4 Substrate level phosphorylation occur in
(a) Glucose to G-6-P (b) F-6-P to F-1,6 BP (c) PEP to pyruvate (d) DiHAP to PGAL

Q5 Position of Phosphate Group Change in Glycolysis within same compound
(a) 2nd step (b) 8th step (c) 7th step (d) 10th step

Q6 Process common in Nostoc & Yeast Cell
(a) Light Rxn (b) Dark Rxn
(c) Glycolysis (d) all

Q7 Oxygen not involve in
(a) Respiration (b) Aerobic Respiration
(c) Glycolysis (d) all

Q9 Number of NADH Form in Glycolysis when one molecule of Pyruvate Form

(a) one (b) two (c) three (d) Four

Q10 Oxidation of PGAL give 1,3 BPG where NAD^+ ____ into ____

(a) Oxidise, NADH (b) Reduce, NADH (c) Reduce, NADPH (d) all

Q11 Glycolysis Absent in

(a) HIV (b) Methanobacterieum (c) RBC (d) all

Q12 Occur in cytoplasm of Animal cell

(a) Centriole (b) Glycolysis (c) Protein synthesis (d) all

Q13 Number of ATP in Glycolysis is

(a) One (b) two (c) Four (d) Five

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lecture - 04

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- link Rxn
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3PGA → 2PGA

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(a) one (b) two (c) three (d) Four

G → 2 × PGAL ⊢ 2 NADH → P × 2

Q10 Oxidation of PGAL give 1,3 BPG where NAD^+ ____ into ____

(a) Oxidise, NADH (b) Reduce, NADH (c) Reduce, NADPH (d) all

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Q13 Number of ATP in Glycolysis is

(a) One (b) two (c) Four (d) Five

link Reaction

Glu ⟶ Pyruvate

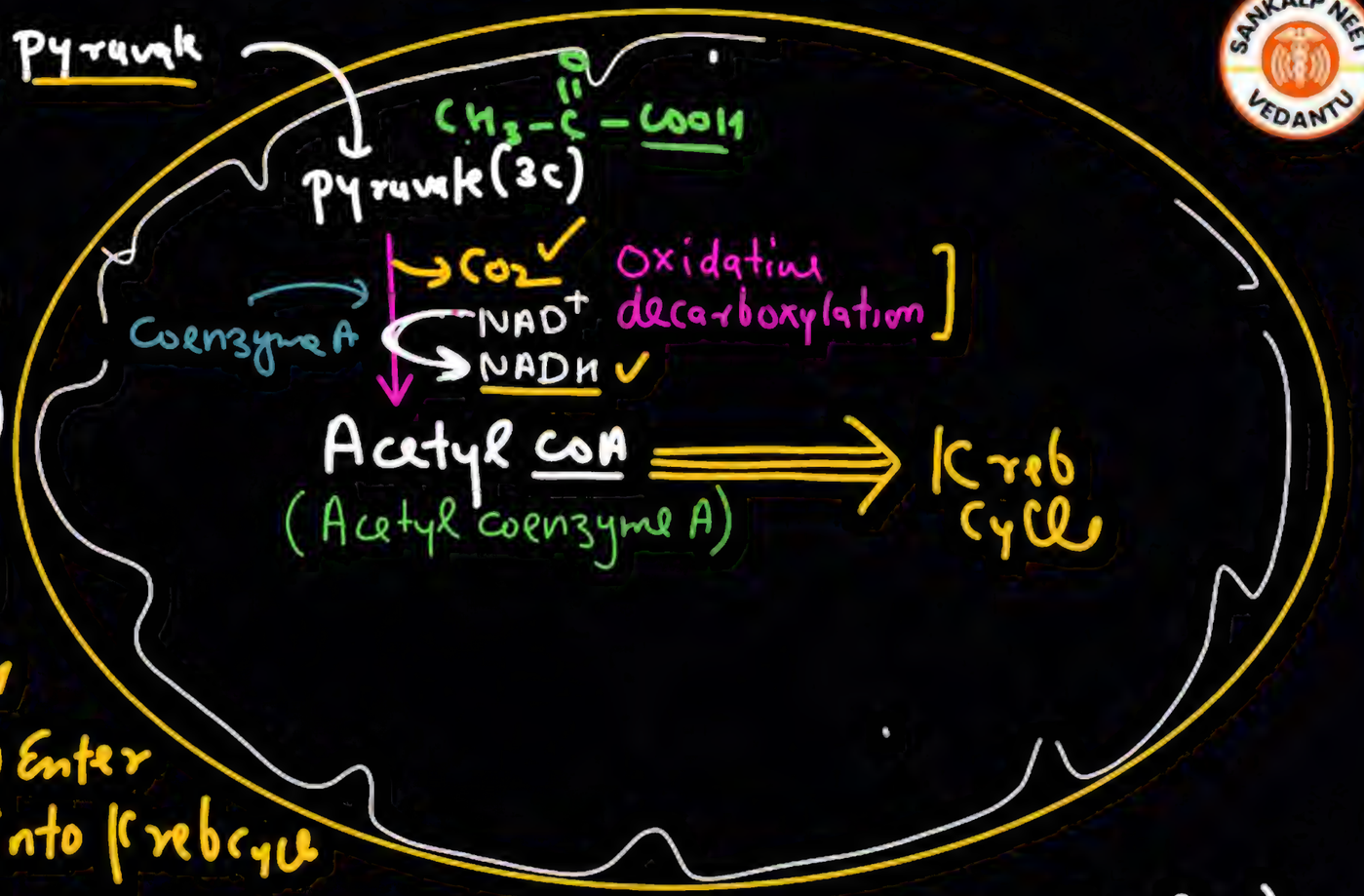
location – Pyruvate Enter into mitochondria
In link Rxn (Link B/w Glycolysis & Krebs cycle)

Process → Oxidation + Decarboxylation
(Oxidative Decarboxylation)

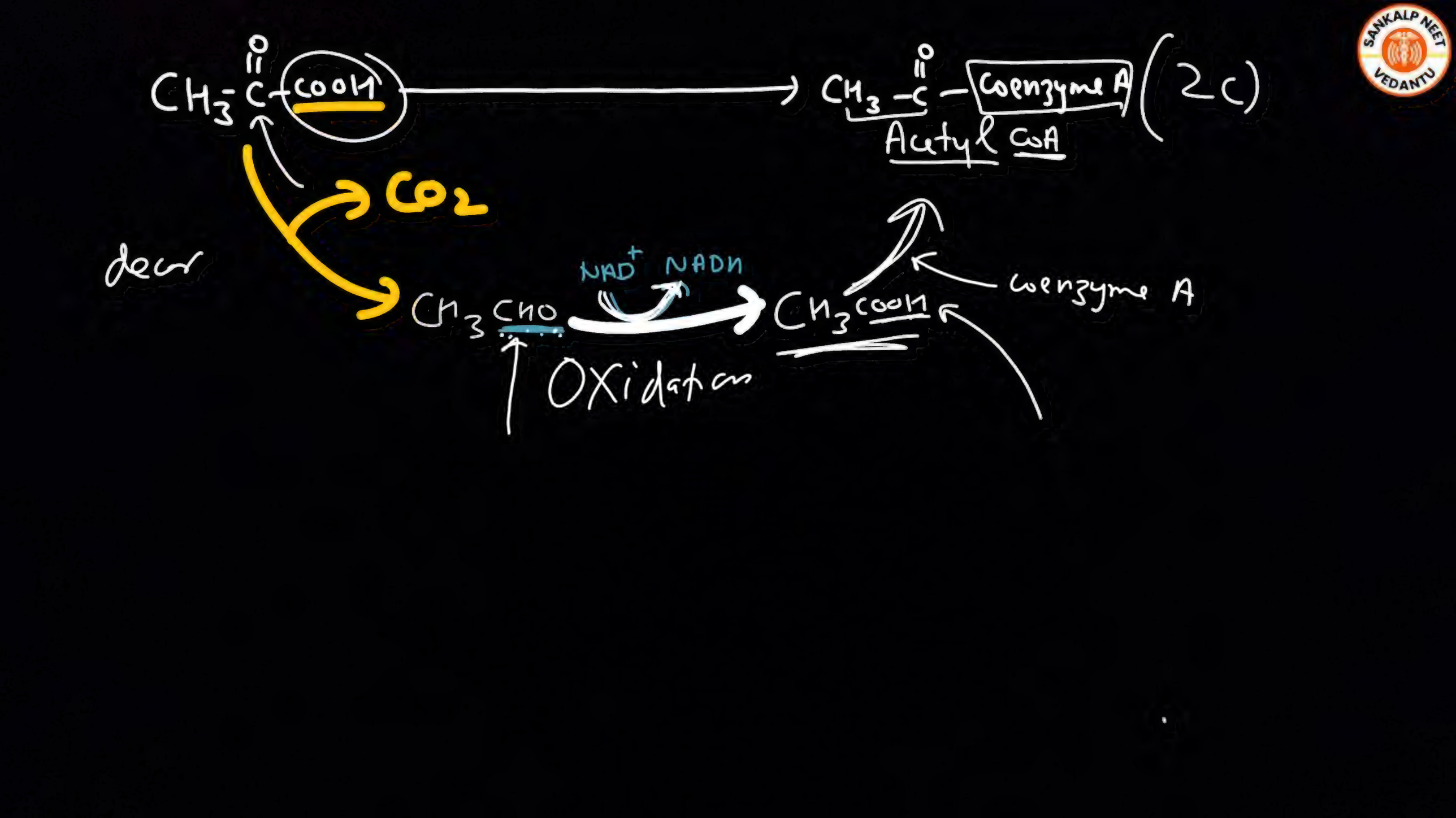
product → From one Pyruvate (1 CO_2, 1 NADH, 1 Acetyl CoA → Enter into Krebs cycle)

Enzyme → Pyruvate dehydrogenase

Cofactor → Mg^{+2} | 1 NAD^+ | Coenzyme A



note – When NADH involve Enzyme dehydrogenase)


CH3 C COOH
CH3 C Coenzyme A
Acetyl CoA
(2C)
CO2
decr
NAD+ NADH
CH3 CHO
CH3 COOH
Coenzyme A
Oxidation

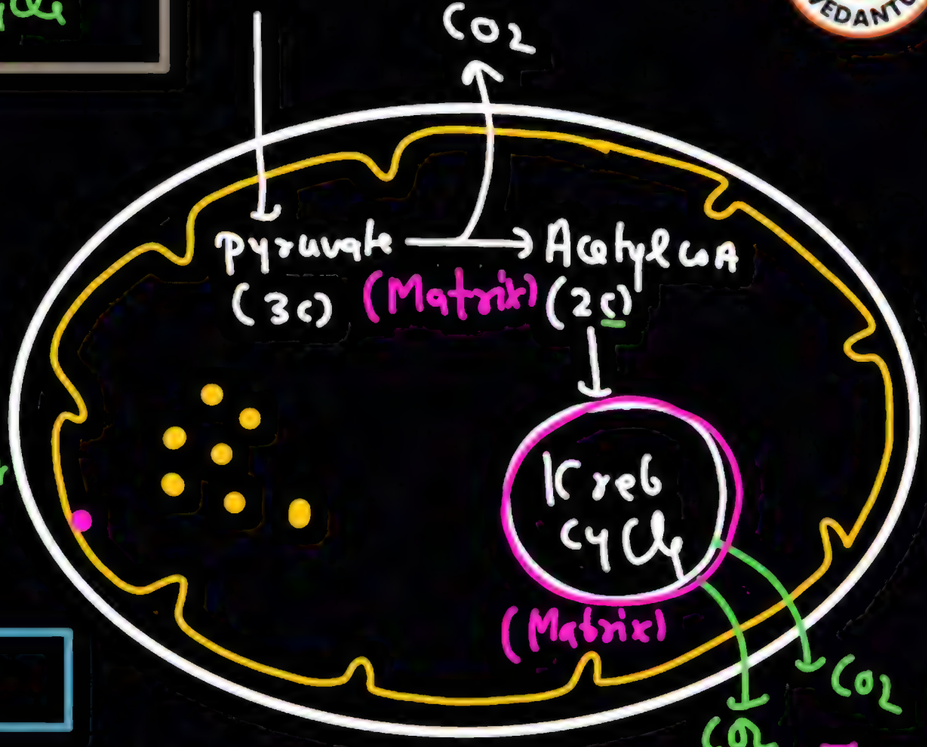
kreb cycle | Citric Acid cycle | TCA - Tricarboxylic Acid cycle

→ location – Matrix of Mitochondria

→ total step – 8 (total Reaction - 8) [7-Enzyme matrix
Enzyme - Eight
1 Enzyme – membrane Bound – Succinate dehydrogenase]

→ Acetyl CoA (2c) → Substrate Enter into Kreb Cycle and get oxidised completely → two CO_2 Form

- Product of Kreb cycle → 3NADH, 1$FADH_2$, 1ATP, 2CO_2

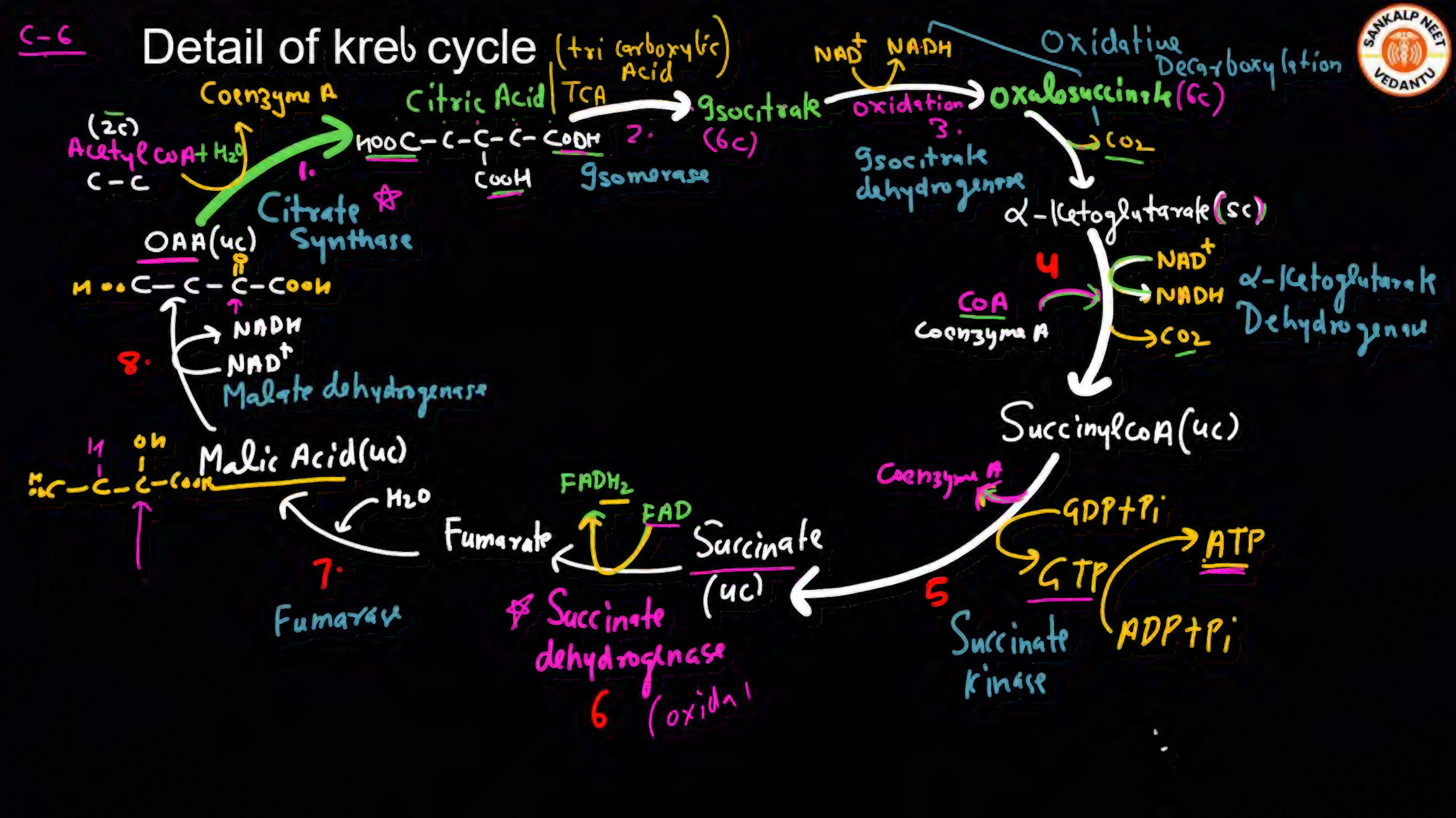


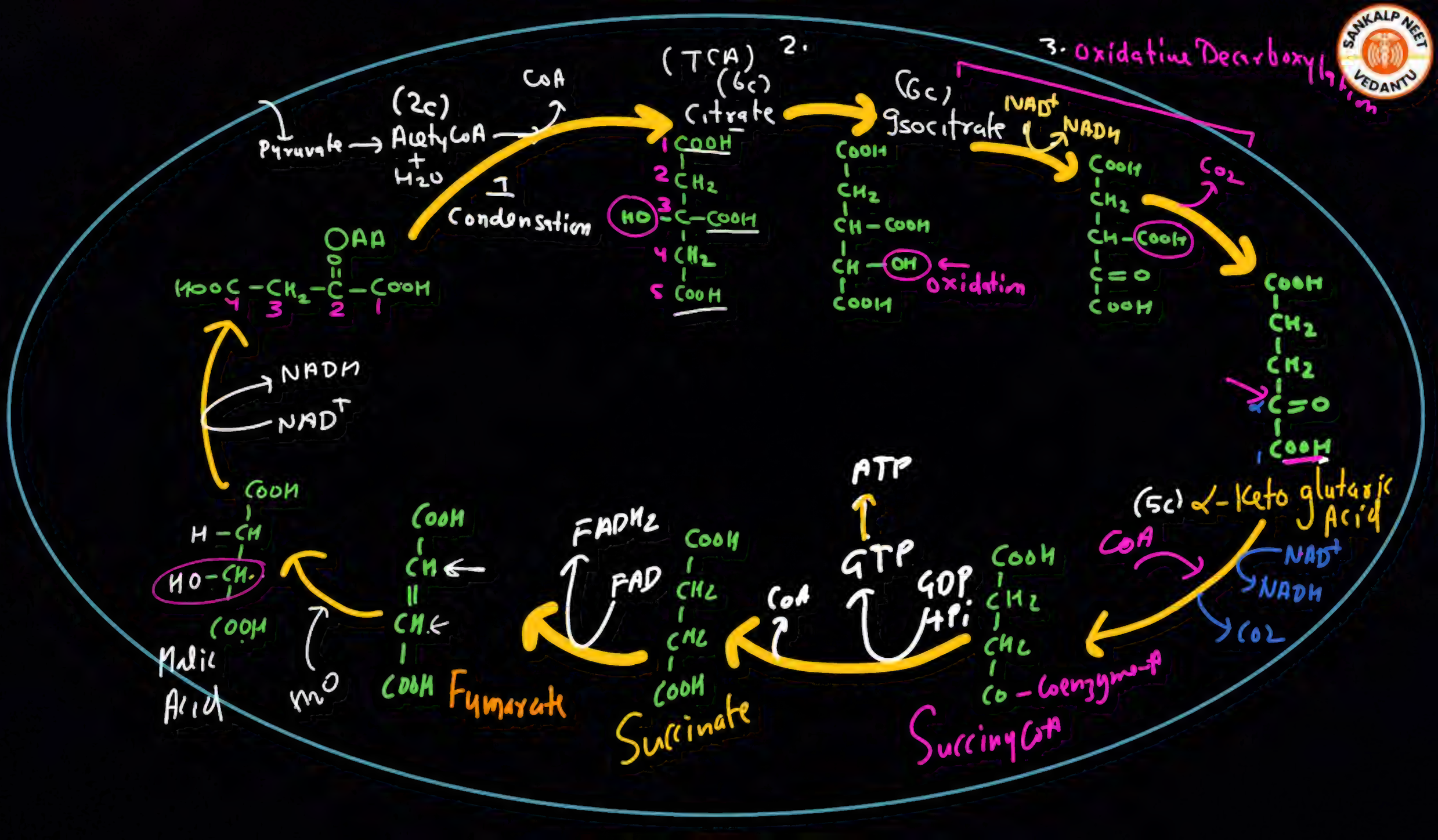
Kreb cycle → Acetyl CoA (2c) + 3NAD^+ + FAD + ADP + P_i ⟶ 2CO_2 + Coenzyme A + 3NADH + $FADH_2$ + ATP

Can - Citrate
1
Acetyl CoA
CoA
Intelligent
Isocitrate
2.
Om
Oxalosuccinate
(6c)
3
NAD+ NADH
CO2
Karan
(5c)
α-Ketoglutarate
NAD+
NADH
CO2
4
Solid Succinyl CoA
5
GTP → ATP
Soml Succinate
Friegr
6
FAD
FADH2
Fumarate
Mafia
Malate
7
H2O
Operation
Oxaloacetate
8
NADH
NAD+
NAD+ → NADH
(Reduct)

C-C

Detail of kreb cycle




(TCA)
2.
3. Oxidative Decarboxylation
Pyruvate
(2c)
Acetyl CoA
+
H_2O
CoA
1
Condensation
(6c)
Citrate
OAA
(6c)
Isocitrate
NAD+
NADH
Oxidation
CO_2
(5c) α-Keto glutaric Acid
NAD+
NADH
CO_2
CoA
Co-Coenzyme-A
Succinyl CoA
ATP
GTP
GDP
+Pi
CoA
Succinate
$FADH_2$
FAD
Fumarate
H_2O
Malic Acid
NADH
NAD^+
SANKALP NEET
VEDANTU

Important points Kreb cycle

(a) Location

(b) Products → 3NADH, 2CO_2
1$FADH_2$
1 GTP/1ATP

(c) First product → Citric Acid
(3 COOH Group)

(d) Number of oxidative → 2
Decarboxylation
(Co2 leave
NADH From

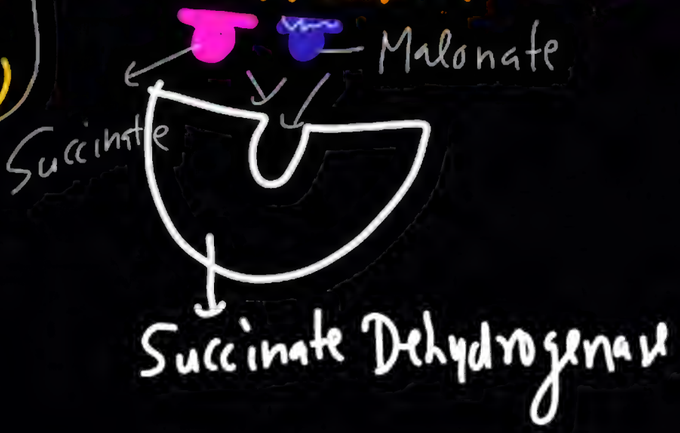
(Isocitrate → oxalosuccinate
↓
α-Ketoglutarate

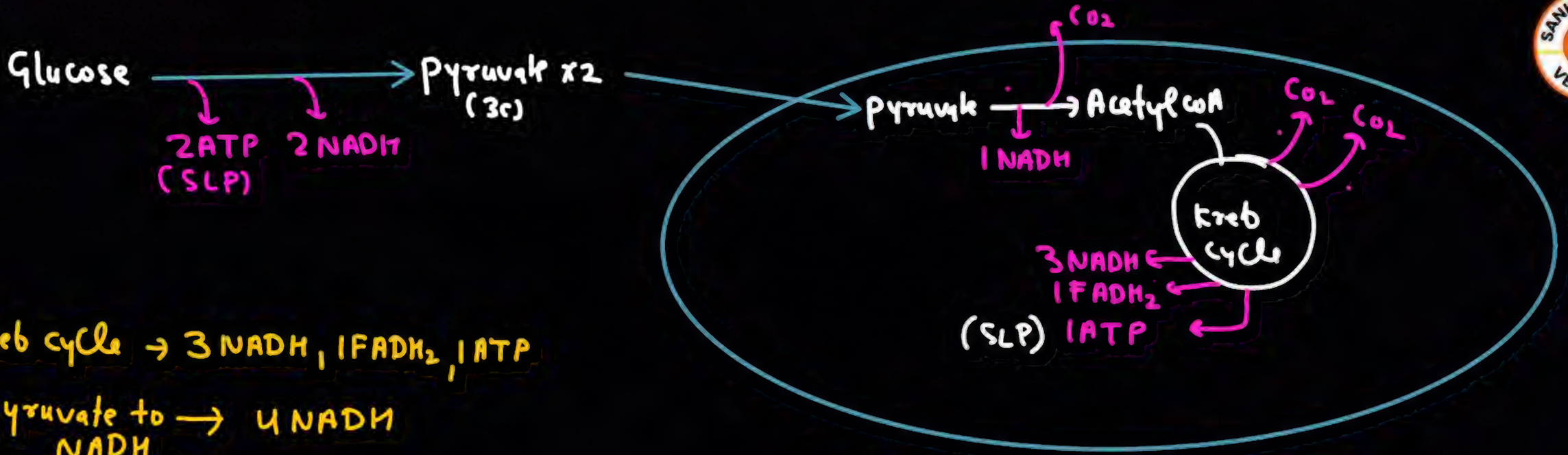
(α-Ketoglutarate → Succinyl CoA)

(e) Direct ATP → one step
(Succinyl CoA → Succinate)
SLP - Substrate level phosphorylation

(f) Enzyme - ① Citrate synthase
② Succinate dehydrogenase (Substrate (Succinate)
Product (Fumarate)

(inhibitor
- Malonate





- Kreb cycle → 3 NADH, 1 $FADH_2$, 1 ATP
- 1 pyruvate to NADH → 4 NADH

Complete oxidation
(Link Rxn + Kreb cycle

- 1 Glucose total NADH → Glycolysis = 2 → 2
  Kreb + link = 4 × 2 pyruvate = 8
  (1 Pyruvate)
  10 NADH

- SLP in Kreb cycle = 1 ATP
- SLP in Kreb cycle From Glucose = 2 ATP

[1 Glu → 2 pyruvate → 2 Kreb cycle]

- No. of $FADH_2$ → Kreb = 1 cycle
- No. of $FADH_2$ → one Gluwa = 2 in Kreb cycle

ATP Balance sheet (1 NADH = 3 ATP 1 $FADH_2$ = 2 ATP)

Glycolysis → 2 ATP → Direct SLP → 2

2 NADH → in mitochondria (oxidative phosphorylation) → 6

8 ATP

2 pyruvate → 2 Acetyl CoA → 2 NADH → 6 ATP

(Mitochondria – O.P)

1 Acetyl CoA → (Kreb cycle) →

3 NADH = 9 ATP

1 $FADH_2$ = 2 ATP

1 GTP = 1 ATP

} Oxidative Phosphorylation

12 ATP X 2 = 24

38 ATP)

DOP A -03

Q1 Acetyl coA Derived From
(a) Pyruvate in Cytoplasm (b) Oxidative decarboxylation in Mitochondria membrane (c) Pyruvate in matrix of Mitochondria (d) none

Q2 Number of NADH in link Rxn From one pyruvate
(a) one (b) two (c) three (d) Four

Q3 No. of NADH in link Rxn From one Glucose
(a) one (b) two (c) three (d) Four

Q4 Number of ATP By SLP in Kreb cycle
(a) one (b) two (c) three (d) none

Q5 Number of ATP By SLP in Kreb cycle From one GLUCOH
(a) one (b) two (c) three (d) Four

Q6 Oxidative Decarboxylation occur in
(a) Kreb cycle (b) Link Rxn (c) Glycolysis (d) Both

Q7 Step in which $FADH_2$ Form
Use Enzyme
(a) Succinate decarboxylase
(b) Succinate dehydrogenase
(c) Citrate Synthase
(d) all

Q8 Malate to OAA is
(a) Reduction (b) oxidation (c) Oxidative decarboxylation (d) all

Q9 Number NADH in Kreb cycle From one Glucose
(a) Six (b) three (c) Four (d) Five

Q10 In which step SLP occur in Kreb cycle
(a) Succinate to Fumerate (b) Succinyl CoA to Succinate
(c) Malate to OAA (d) none

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Respiration in plants

lecture – 06

Botany

TARUN SIR

Topic 2-30

→ Introduction

→ Respiratory Substrate

→ Glycolysis

→ Aerobic Respiration
- link Rxn
- Kreb cycle
- ETS

→ Anaerobic Respiration

→ ATP Balance sheet

→ Amphibolic pathway

→ RQ

cell theory

Today's Goal

→ Introduction

→ Respiratory Substrate

DOP A -03

Q1 Acetyl coA Derived From
(a) Pyruvate in Cytoplasm (b) Oxidative decarboxylation in Mitochondria membrane (c) Pyruvate in matrix of Mitochondria (d) none

Q2 Number of NADH in link Rxn From one pyruvate
(a) one (b) two (c) three (d) Four

Q3 No. of NADH in link Rxn From one Glucose
(a) one (b) two (c) three (d) Four

Q4 Number of ATP By SLP in Kreb cycle (Succinyl CoA)
(a) one (b) two (c) three (d) none

Q5 Number of ATP By SLP in Kreb cycle From one GlucoH
(a) one (b) two (c) three (d) Four

Q6 Oxidative Decarboxylation occur in
(a) Kreb cycle (b) Link Rxn (c) Glycolysis (d) Both a & b

Q7 Step in which $FADH_2$ Form Use Enzyme
(a) Succinate decarboxylase (b) Succinate dehydrogenase (c) Citrate Synthase (d) all

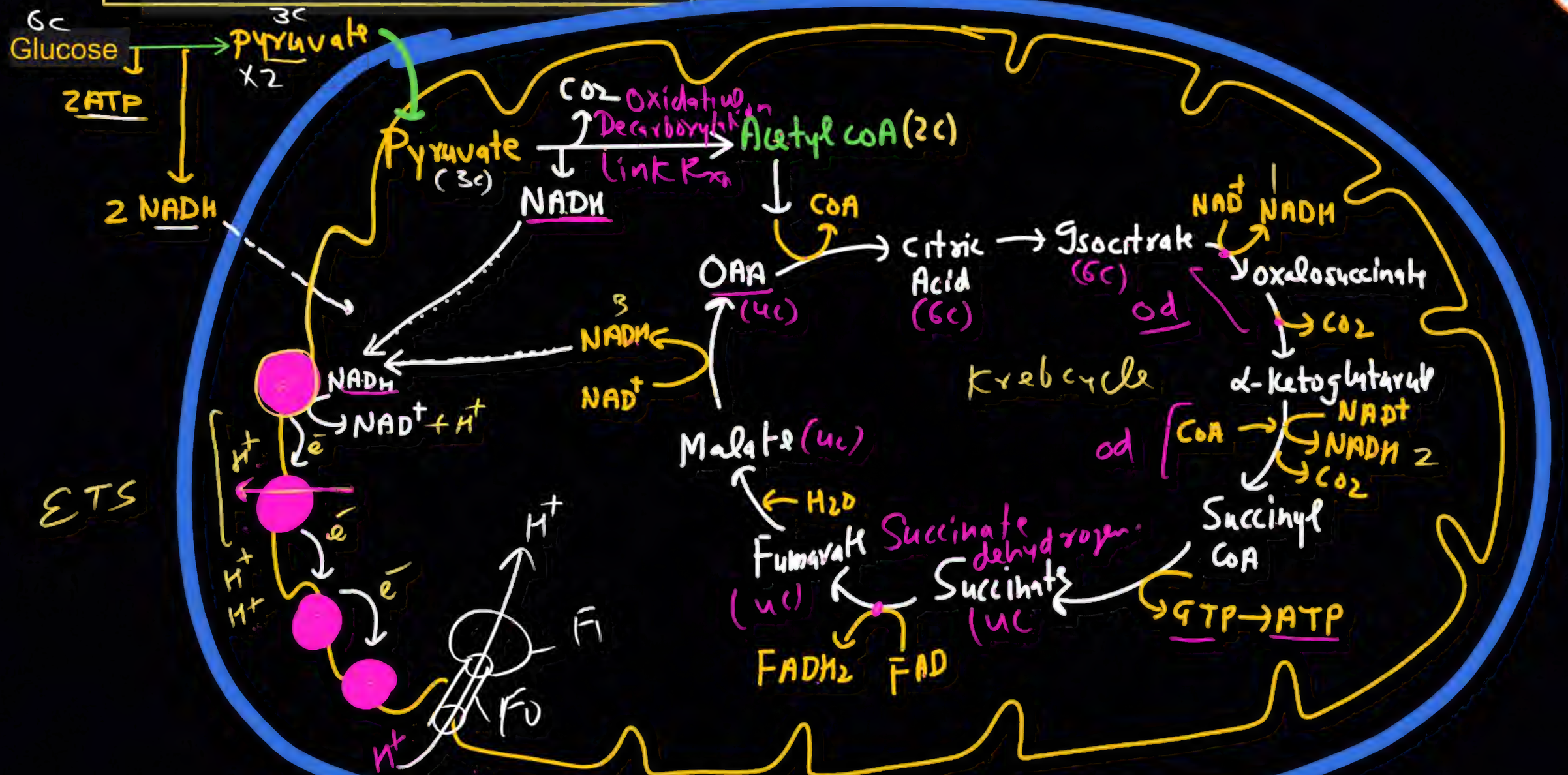
Q8 Malate to OAA is
(a) Reduction (b) Oxidation (c) Oxidative decarboxylation (d) all

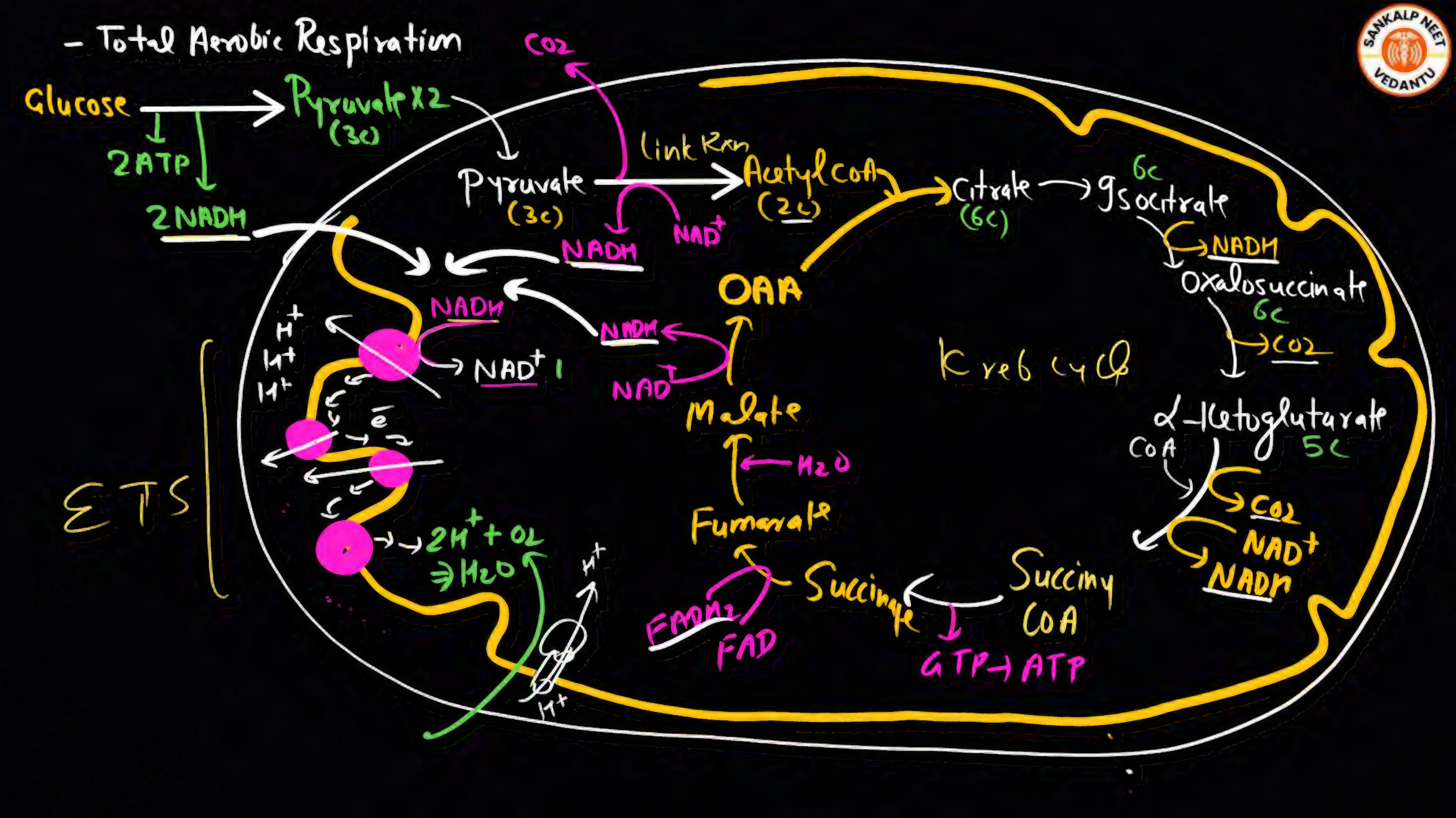
Q9 Number NADH in Kreb cycle From one Glucose
(a) Six (b) three (c) Four (d) Five

Kreb cycle - 3 NADH
One Glucose 6

Q10 In which step SLP occur in Kreb cycle
(a) Succinate to Fumerate (b) Succinyl to Succinate
CoA
(c) Malate to OAA (d) none

what we studied




- Total Aerobic Respiration
Glucose
Pyruvate X2
(3C)
2ATP
2NADH
CO2
Link Rxn
Pyruvate
(3C)
Acetyl CoA
(2C)
NADH
NAD+
Citrate
(6C)
6C
Isocitrate
NADH
Oxalosuccinate
6C
CO2
OAA
NADH
NADH
NAD+
Malate
H2O
Fumarate
Kreb Cycle
α-Ketoglutarate
5C
CoA
CO2
NAD+
NADH
ETS
H+
H+
H+
e-
2H+ + O2
H2O
FADH2
FAD
Succinate
Succiny
CoA
GTP → ATP
H+
H+
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two type of ATP synthesis in Respiration

1. Substrate level phosphorylation → High Energy compound convert into low Energy compound

PEP ⟶ Pyruvate

1,3BPG ⟶ 3PG

Glycolysis → two step SLP occur

Two ATP By SLP

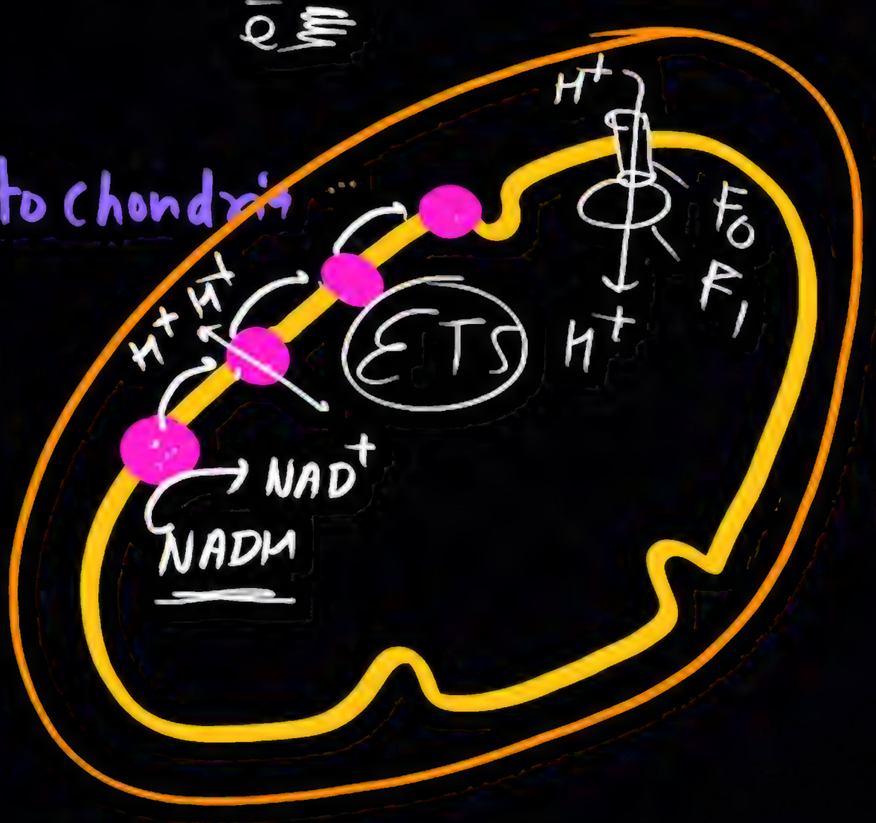
Succinyl CoA —(ADP → ATP)→ Succinate

SLP → one step in Kreb Cycle

2. **Oxidative phosphorylation** — ATP Synthesis Mitochondria

Mitochondria → oxidation of NADH & $FADH_2$ in ETS → $\bar{e}$ move From one Enzyme complex to other → Energy of $\bar{e}$ use to pump proton — intermembrane space

(Proton give ATP → By → Fo-F1



Important points About Kreb cycle & link Rxn

1 NADH = 3 ATP 1 $FADH_2$ = 2

(a) Glycolysis product is – Pyruvate, 2NADH, 2ATP

(b) Pyruvate Undergo no. of Oxidative Decarboxylation in Mitochondria – 3 } 1 Link Rxn + 2 Kreb cycle = 3

(c) No. of oxidative decarboxylation in Kreb cycle } 2

(d) No. of NADH from pyruvate [NADH = 4 (1 Link Rxn + 3 Kreb cycle)] From complete oxidation in Mitochondria

(e) No. of ATP By SLP in → Glycolysis – 2
→ Kreb cycle – 1
• From one Glucose in Kreb cycle } 2

(f) Step in $FADH_2$ From Substrate & product – Succinate to Fumarate

(g) No. of NADH & $FADH_2$ in Kreb Cycle } NADH = 3, $FADH_2$ = 1

(h) No. of ATP From Oxidative phosphorylation
- Glycolysis → 2NADH = 6 ATP
- Link Rxn → 1 NADH = 3 ATP
- Link Rxn From one Glucose = 2 NADH = 6 ATP
- 1 Kreb cycle = 3 NADH = 9, 1 $FADH_2$ = 2 } 11 ATP

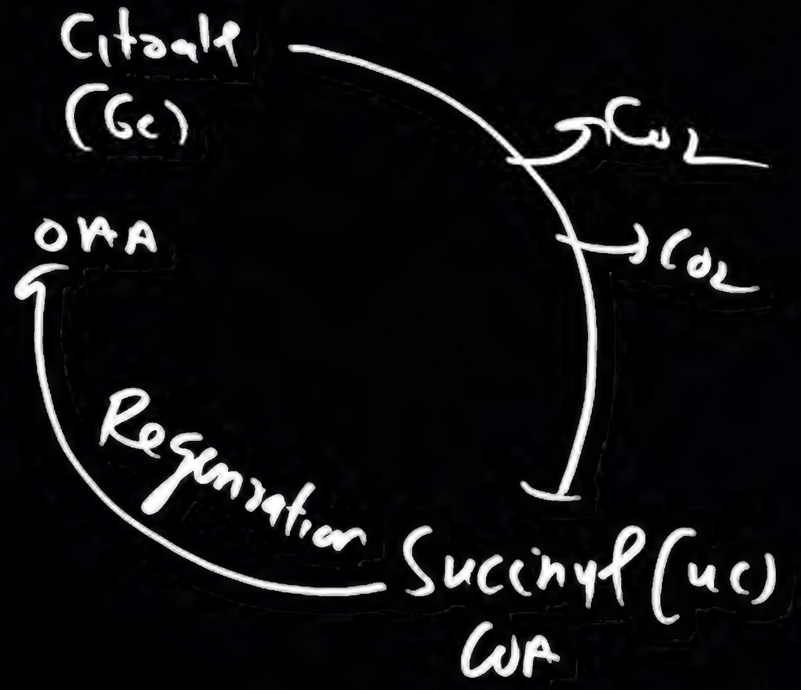
Kreb cycle From one Glucose = 22 ATP

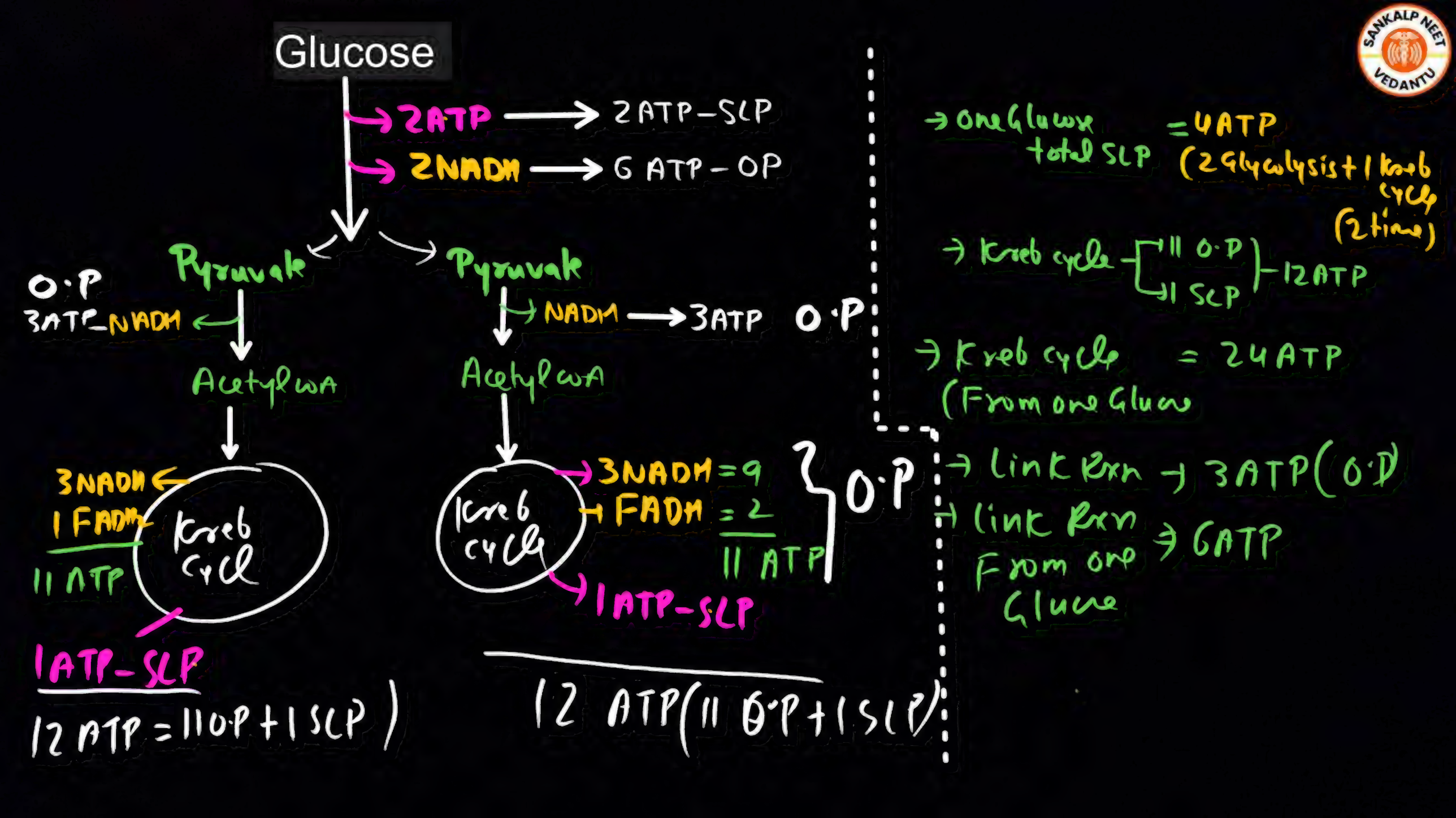
(a) – Step in which NADH Form in Krebs cycle → 3 step [isocitrate to oxalosuccinate → α-ketoglutarate to Succinyl CoA, Malate to OAA]

(b) Number of oxidative Decarboxylation (Krebs cycle) ⇒ 2

→ Step in which GTP Form → Succinyl CoA to Succinate

→ Product From which Regenration start in krebs cycle → Succiny CoA (4C)




Glucose
2ATP → 2ATP-SLP
2NADH → 6 ATP - OP
Pyruvate
Pyruvate
O·P
3ATP-NADH
NADH → 3ATP O·P
Acetyl CoA
Acetyl CoA
3NADH
1 FADH
11 ATP
Kreb cycle
Kreb cycle
3NADH = 9
FADH = 2
11 ATP
O·P
1ATP-SLP
1ATP-SLP
12 ATP = 11 O·P + 1 SLP
12 ATP (11 O·P + 1 SLP)
→ one Glucose = 4ATP
total SLP (2 Glycolysis + 1 Kreb cycle (2 time)
→ Kreb cycle → 11 O·P, 1 SLP → 12ATP
→ Kreb cycle = 24ATP
(From one Glucose
→ link Rxn → 3ATP (O·P)
→ link Rxn From one Glucose → 6ATP

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Respiration in plants
Lecture-06

Botany

TARUN SIR

Topic 2-30

→ Introduction

→ Respiratory Substrate

→ Glycolysis

→ Aerobic Respiration
- link Rxn
- Kreb cycle
- ETS

→ Anaerobic Respiration

→ ATP Balance sheet

→ Amphibolic pathway

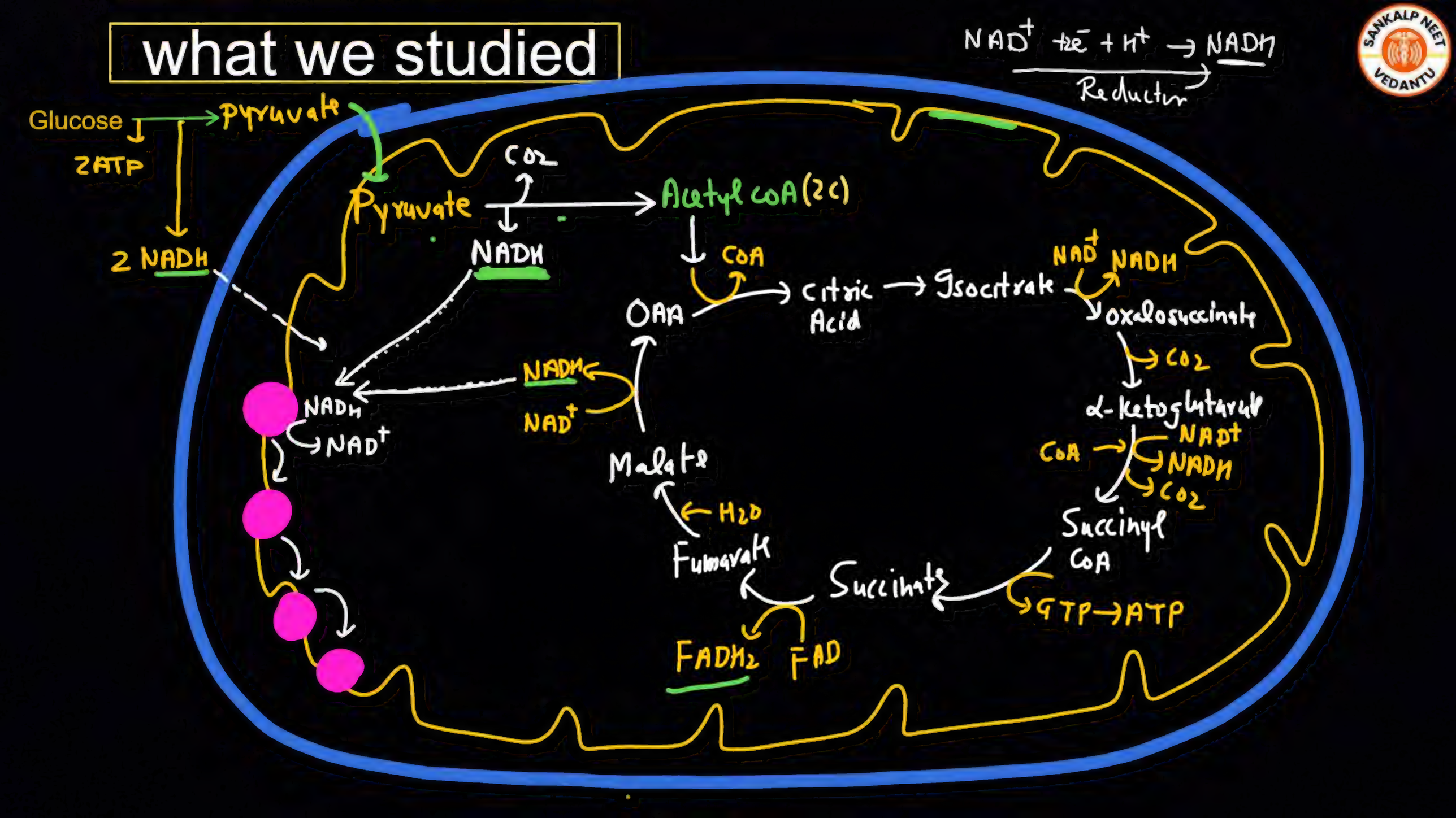
→ RQ

cell theory

Today's Goal

- ETS
- → Anaerobic Respiration

what we studied

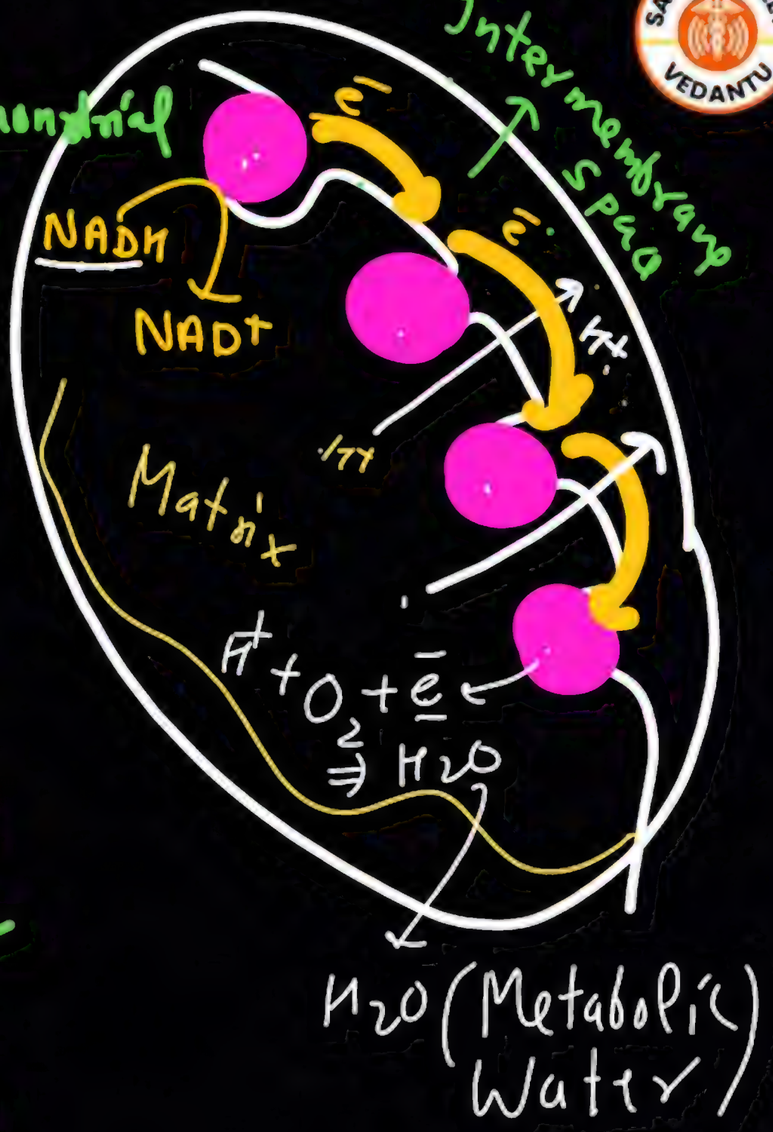


Electron transport System

Meaning – Inner Mitochondrial Membrane
Enzyme complex with electron carrier

location
Inner mitochondrial Membrane

Role → NADH & $FADH_2$ Oxidise
$\bar{e}$ move through Electron carriers
Energy of $\bar{e}$ use to pump proton in intermembrane Space From matrix



– Enzyme complex
(Proteins + $\bar{e}$ carrier)
Present in Group

Source of $\bar{e}^-$ For ETS
- NADH
- $FADH_2$

Final $\bar{e}$ Acceptor is – O_2 which Form metabolic water

14.4.2 Electron Transport System (ETS) and Oxidative Phosphorylation

The following steps in the respiratory process are to release and utilise the energy stored in $NADH+H^+$ and $FADH_2$. This is accomplished when they are oxidised through the electron transport system and the electrons are passed on to O_2 resulting in the formation of H_2O. The metabolic pathway through which the electron passes from one carrier to another is called the ***electron transport system*** (ETS) (Figure 14.4) and it is present in the inner mitochondrial membrane. Electrons from NADH

Enzyme complex in ETS

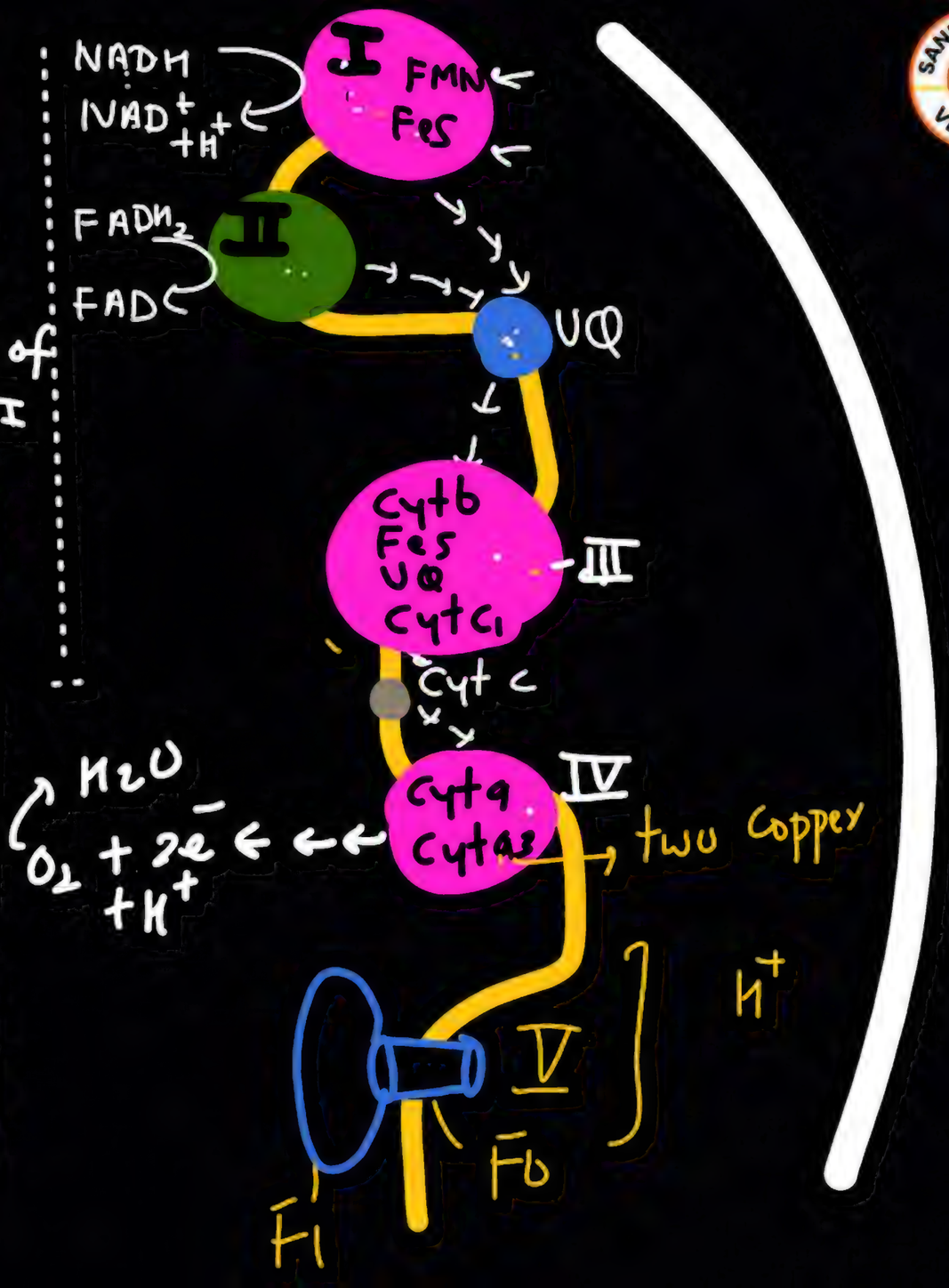
Complex I → Accept $\bar{e}$ From NADH → Oxidise NADH
→ Reduce Ubiquinone(UQ)
(Give $\bar{e}$ to ubiquinone

FMN, Fes } $\bar{e}$ carrier of complex I

UQ - Ubiquinone → ($UQ + 2\bar{e} + 2H^+ \rightarrow UQH_2$)
(oxidise Form) (Reduce Form)

Complex III → Accept $\bar{e}$ From UQH_2
$\bar{e}$ carrier → Cytb, Fes, UQ, cyt C_1
- Give $\bar{e}$ to complex IV through Cyt-C

Complex IV → Accept $\bar{e}$ From cyt c | Cyt a, Cyt a_3
- Give $\bar{e}$ to Oxygen

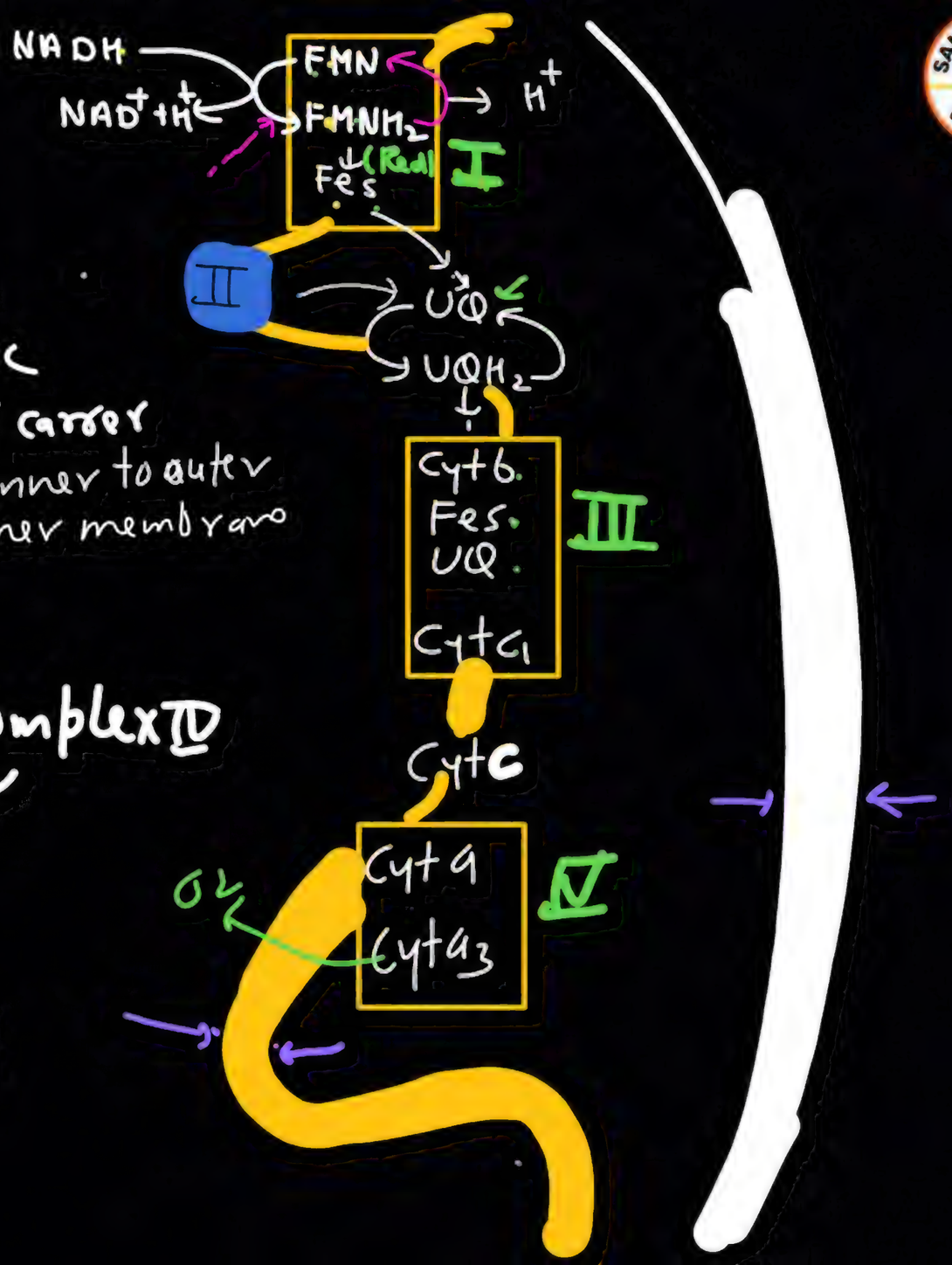


steps in ETS

NADH → Complex I (FMN, Fes) → UQ → Complex III (cyt b, Fes, UQ, cyt c_1) → Cyt c (mobile ē carrer, move From inner to outer side of inner membrane) → Complex IV (cyt a, cyt a_3 (two copper)) → O_2 (Final ē Acceptor) → H_2O

$FADH_2$ → UQ → Complex III → Cyt c → Complex IV → O_2 → H_2O From

Note - Most Enzyme complex have Iron, only Cyt-a_3 → Copper present



NADH use → NADH

Matrix → I → $4H^+$ (intermembrane space)

II → UQ

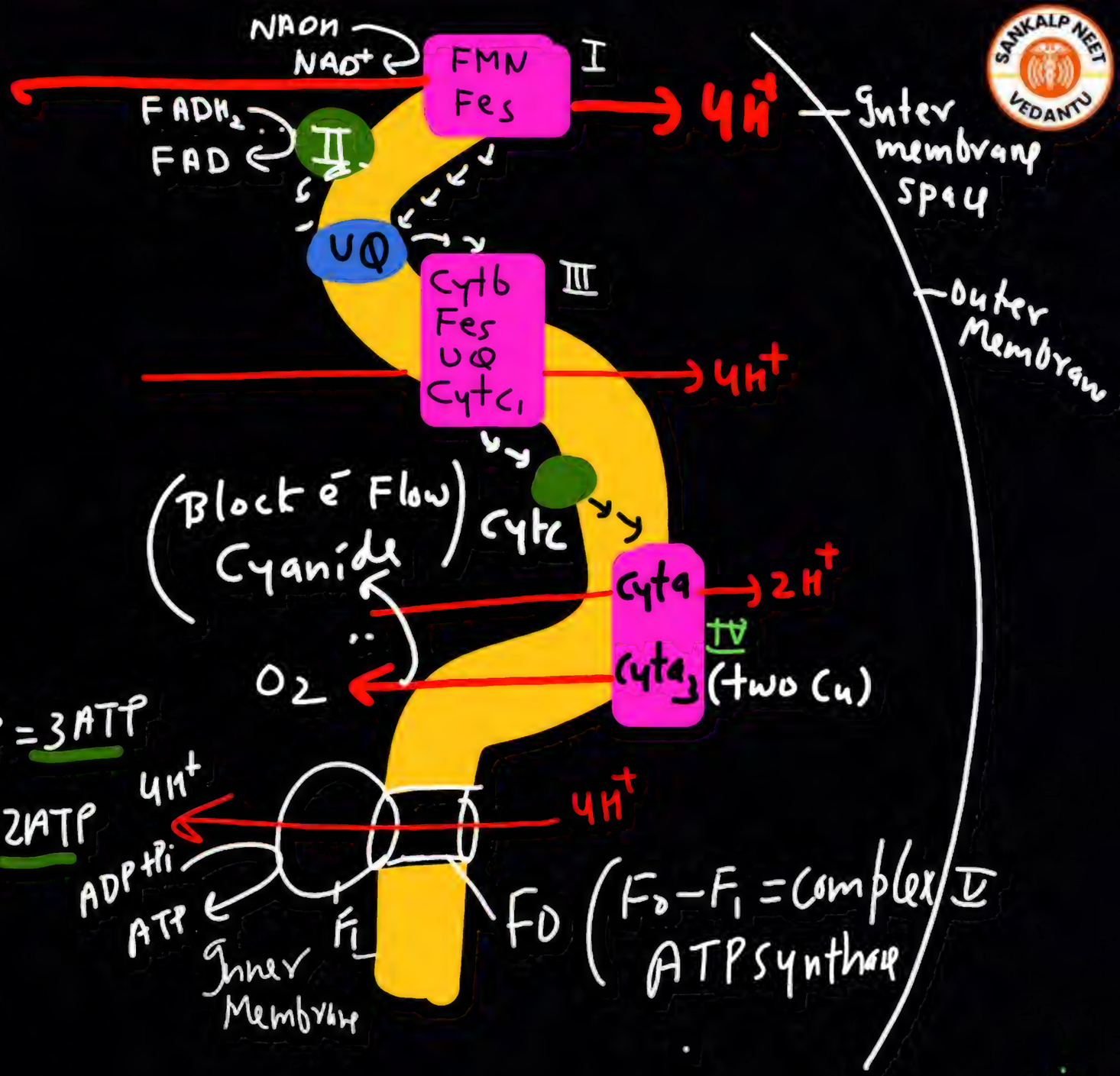
→ III → $4H^+$

→ Cytc

→ IV → $2H^+$

NADH → Energy + move → $10H^+$ = 2.5 ATP = 3ATP

$FADH_2$ → Energy move → $6H^+$ → 1.5 ATP = 2ATP



produced in the mitochondrial matrix during citric acid cycle are oxidised by an NADH dehydrogenase (complex I). and electrons are then transferred to ubiquinone located within the inner membrane. Ubiquinone also receives reducing equivalents via $FADH_2$ (complex II) that is generated during oxidation of succinate in the citric acid cycle. The reduced ubiquinone (ubiquinol) is then oxidised with the transfer of electrons to cytochrome c via cytochrome bc_1 complex (complex III). Cytochrome c is a small protein attached to the outer surface of the inner membrane and acts as a mobile carrier for transfer of electrons between complex III and IV. Complex IV refers to cytochrome c oxidase complex containing cytochromes a and a_3, and two copper centres.

Succinate → Fm

UQ → III → Cyt c

When the electrons pass from one carrier to another via complex I to IV in the electron transport chain, they are coupled to ATP synthase (complex V) for the production of ATP from ADP and inorganic phosphate. The number of ATP molecules synthesised depends on the nature of the electron donor. Oxidation of one molecule of NADH gives rise to 3 molecules of ATP, while that of one molecule of $FADH_2$ produces 2 molecules of ATP. Although the aerobic process of respiration takes place only in the presence of oxygen, the role of oxygen is limited to the terminal stage of the process. Yet, the presence of oxygen is vital, since it drives the whole

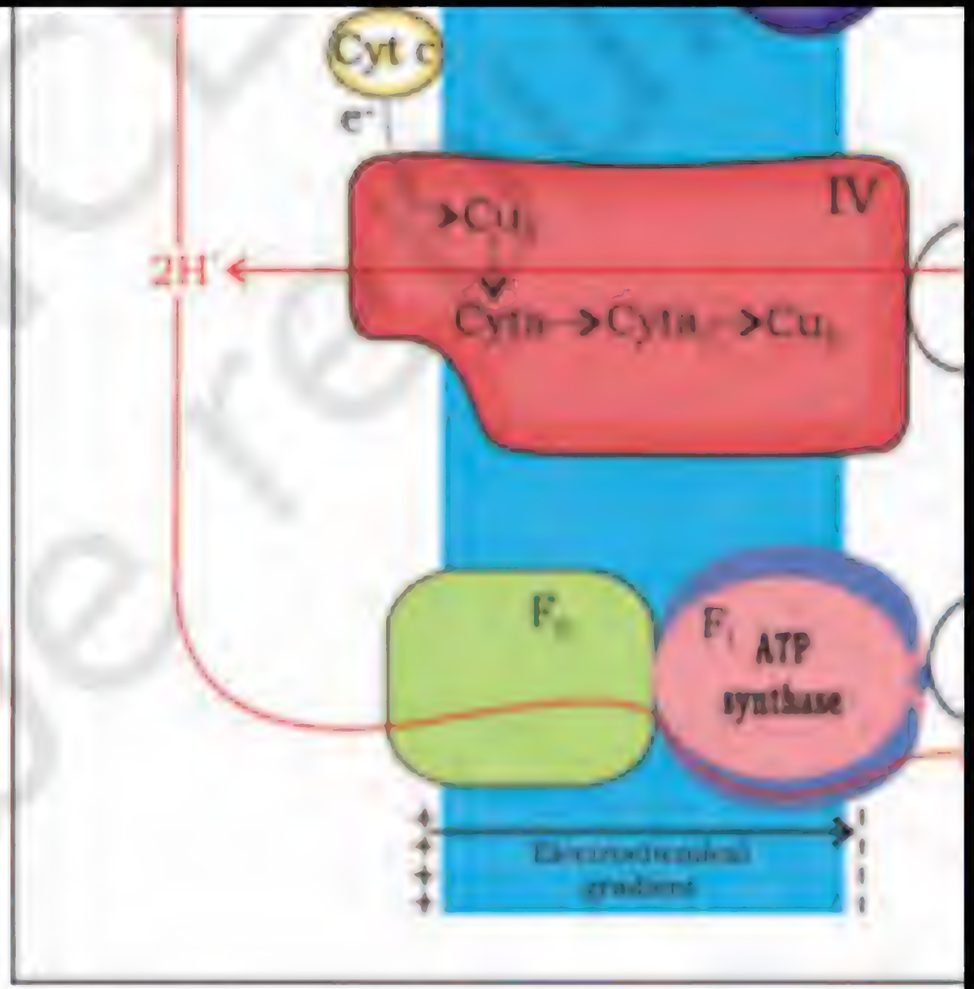
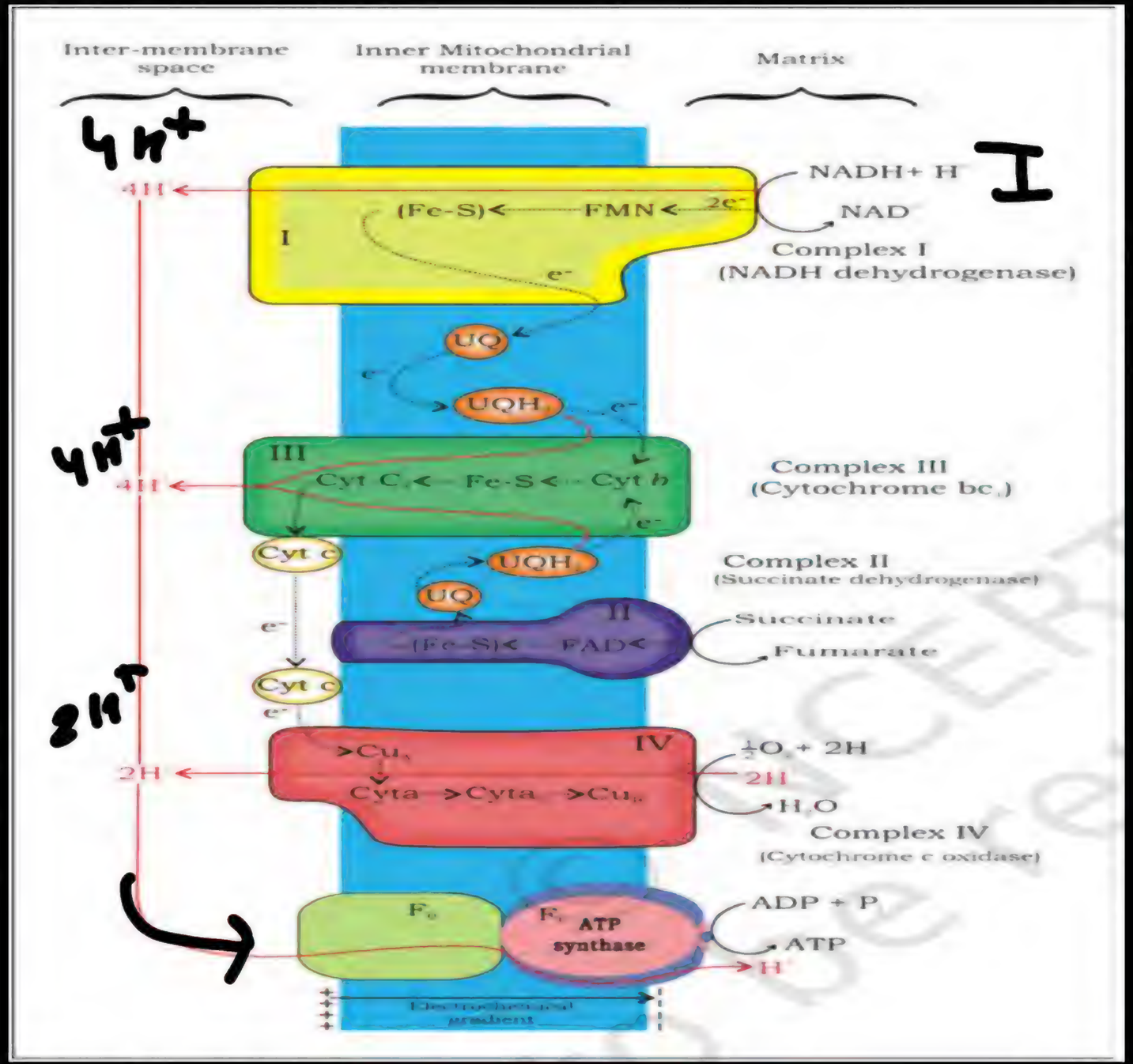


Figure 14.4 Electron Transpor

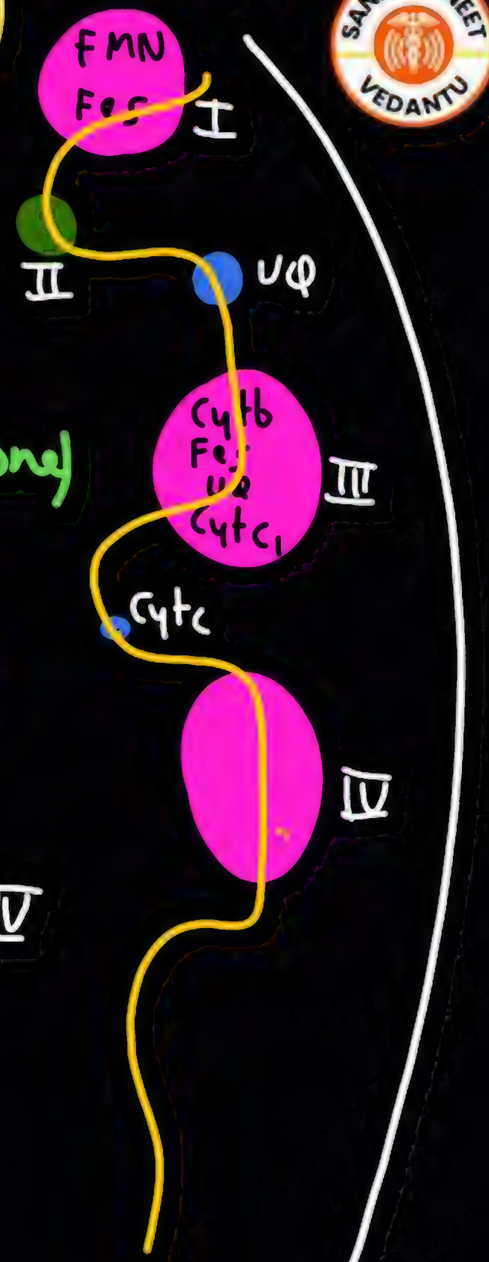
respiration takes place only in the presence of oxygen, the role of oxygen is limited to the terminal stage of the process. Yet, the presence of oxygen is vital, since it drives the whole process by removing hydrogen from the system. Oxygen acts as the final hydrogen acceptor. Unlike photophosphorylation where it is the light energy that is utilised for the production of proton gradient required for phosphorylation, in respiration it is the energy of oxidation-reduction utilised for the same process. It is for this reason that the process is called oxidative phosphorylation.

You have already studied about the mechanism of membrane-linked ATP synthesis as explained by chemiosmotic hypothesis in the earlier chapter. As mentioned earlier, the energy released during the electron

Figure 14.4 Electron Transpor


Inter-membrane space
Inner Mitochondrial membrane
Matrix
4H+
4H+
2H+
4H+
4H+
NADH+ H+
NAD+
I
(Fe-S)
FMN
2e-
e-
Complex I
(NADH dehydrogenase)
UQ
UQH2
III
Cyt C1
Fe-S
Cyt b
Complex III
(Cytochrome bc1)
Cyt c
UQH2
UQ
Complex II
(Succinate dehydrogenase)
II
(Fe-S)
FAD
Succinate
Fumarate
Cyt c
IV
Cu A
Cyta
Cyta3
CuB
½O2 + 2H+
2H+
H2O
Complex IV
(Cytochrome c oxidase)
2H+
Fo
F1
ATP synthase
ADP + P
ATP
H+
Electrochemical gradient

Enzyme complex	Electron carrier	Accept Electron From (Oxidise)	Give Electron to (Reduce)
Complex I – NADH Dehydrogenase Complex	FMN_1, Fes	NADH	UQ
Complex II → Succinate dehydrogenase Complex		$FADH_2$	UQ (Ubiquinone)
← Ubiquinone →		→ Complex I, Complex II	Complex III
Complex III → $cytbc_1$ complex or Cytochrome c Reductase	$cytb_1$, Fes, UQ, $cytC_1$	UQH_2 (Ubiquinol)	Cyt c
← Cyt c →		→ Complex III	→ Complex IV
Complex IV → Cytochrom C-oxidase complex	$cyta_1$, $cyta_3$ (two Cu)	→ CytC	→ O_2



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How ATP synthesis occur

$4H^+ = 1\,ATP$

- Oxidation of NADH & $FADH_2$ → $\bar{e}$ move in ETS
- Energy is utilised By $\bar{e}$ movement → Use to pump proton From matrix to intermembrane Space

→ NADH → oxidise → $10\,H^+$
$FADH_2$ → oxidise → $6\,H^+$ } From matrix to intermembrane Space

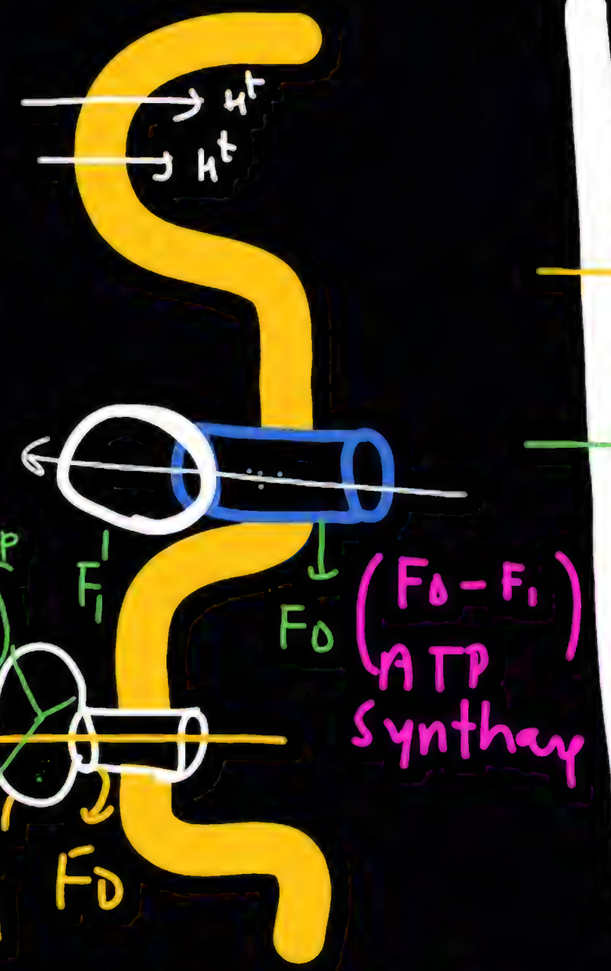
→ Proton come back → From intermembrane space to matrix – through F_0–F_1

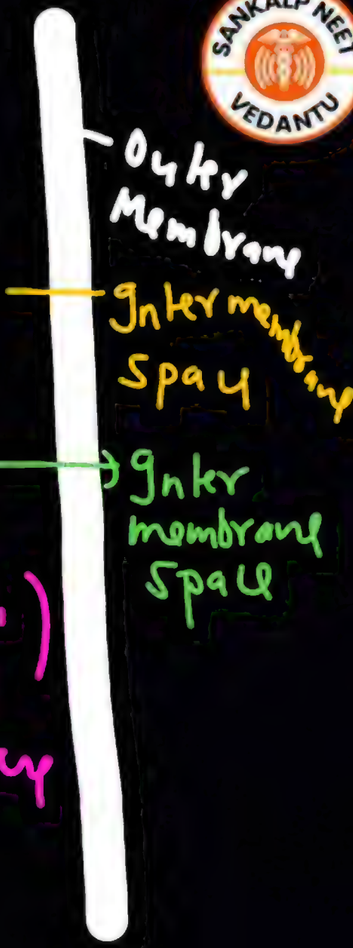
F_0 → Channel / tranmembrane Protein / Integral protein

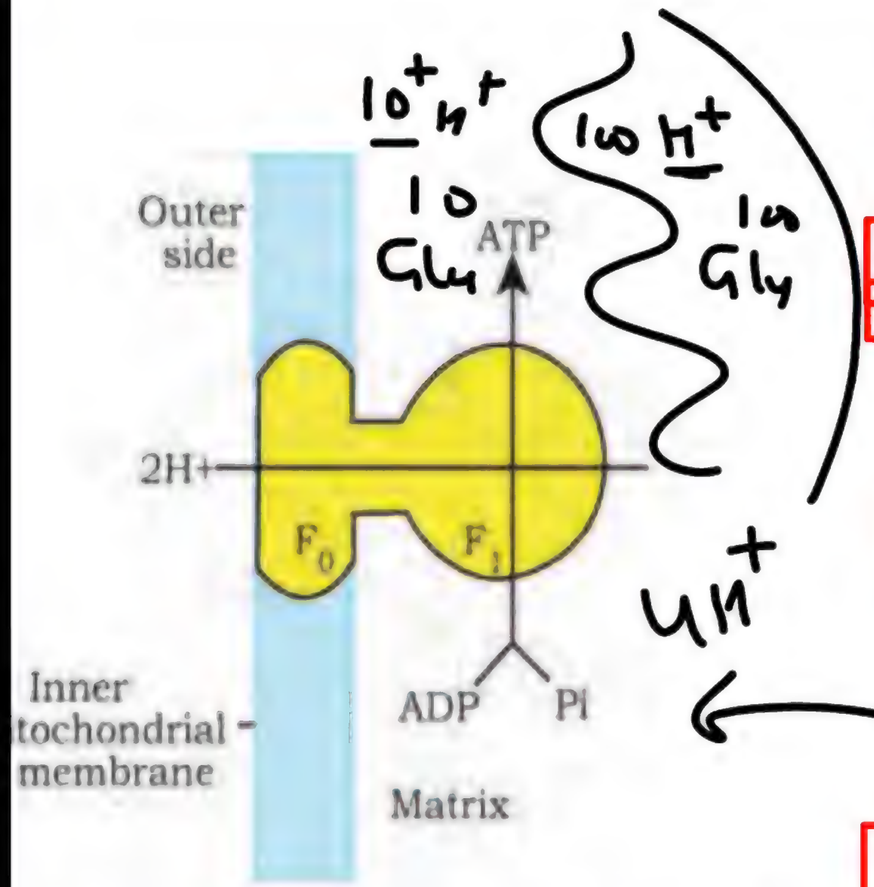
F_1 → head → Peripheral protein

When Proton move through F_0 → Conformation change occur in F_1

Catalytic site Active on F_1 → ATP Synthesis occur







gure 14.5 Diagramatic presentation of ATP synthesis in mitochondria

transport system is utilised in synthesising ATP with the help of ATP synthase (complex V). This complex consists of two major components, F_1 and F_0 (Figure 14.5). The F_1 headpiece is a peripheral membrane protein complex and contains the site for synthesis of ATP from ADP and inorganic phosphate. F_0 is an integral membrane protein complex that forms the channel through which protons cross the inner membrane. The passage of protons through the channel is coupled to the catalytic site of the F_1 component for the production of ATP. For each ATP produced, $2H^+$ passes through F_0 from the intermembrane space to the matrix down the electrochemical proton gradient.

DOPA-04

Q ETS is present in
(a) thylakoid membrane (b) Outer mitochondrial Membrane (c) Inner mitochondrial Membrane (d) Both 1 & 3

Q2 Source of $\bar{e}$ in ETS of Mitochondria
(a) NADH (b) $FADH_2$ (c) Both (d) None

Q3 NADH Give $\bar{e}$ to
(a) Complex I (b) Complex II (c) UQ (d) none

Q4 $FADH_2$ Oxidise UQ via
(a) complex II (b) Complex III (c) complex I (d) Complex IV

Q5 Cytochrome c-oxidase complex Oxidise
(a) Cyt bC_1 (b) Cyt c (c) Oxygen (d) H_2O

Q5 UQ Recieve $\bar{e}$ from
(a) NADH through Complex I (b) $FADH_2$ through Complex II (c) Complex III (d) Both I & II

Q6 Mobile $\bar{e}$ carrier is
(a) Cyt a (b) Cyt c (c) Cyt a_3 (d) Cyt b

Q7 two copper present in
(a) Cyt a (b) Cyt a_3 (c) Cyt b (d) Cyt b_6F

Q8 Energy of $\bar{e}$ of NADH pump H^+ From ____ to intermembrane space
(a) Stroma (b) Matrix (c) Outer Envelop (d) all

Q9 Number of proton move from outer Envelop to Matrix for one ATP synthesis
(a) two (b) three (c) Four (d) ten

Q10 Final $\bar{e}$ Acceptor in ETS is
(a) O_2 (b) Hydrogen (c) H_2O (d) all

MANTHAN NEET 2025 1.0 to 2.0

SANKALP NEET VEDANTU

Respiration in plants
lecture-07

Botany

TARUN SIR

Topic 2-30

→ Introduction

→ Respiratory Substrate

→ Glycolysis

→ Aerobic Respiration
- link Rxn
- Kreb cycle
- ETS

→ Anaerobic Respiration

→ ATP Balance sheet

→ Amphibolic pathway

→ RQ

cell theory

Today's Goal

- ETS
- → Anaerobic Respiration

DOPA-04

Q ETS is present in
(a) thylakoid membrane (b) Outer mitochondrial Membrane (c) Inner mitochondrial Membrane (d) Both 1 & 3

Q2 Source of $\bar{e}$ in ETS of Mitochondria
(a) NADH (b) $FADH_2$ (c) Both (d) None

Q3 NADH Give $\bar{e}$ to
(a) Complex I (b) Complex II (c) UQ (d) none

Q4 $FADH_2$ Reduce UQ via
(a) complex II (b) Complex III (c) complex I (d) Complex IV

Q5 Cytochrome c-oxidase complex Oxidise
(a) Cyt bC_1 (b) Cyt c (c) Oxygen (d) H_2O

Q5 UQ Recieve $\bar{e}$ from
(a) NADH through Complex I (b) $FADH_2$ through Complex II (c) Complex III (d) Both I & II

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(a) Cyt a (b) Cyt c (c) Cyt a_3 (d) Cyt b

Q7 two copper present in
(a) Cyt a (b) Cyt a_3 (c) Cyt b (d) Cyt b_6F

Q8 Energy of $\bar{e}$ of NADH pump H^+ From ____ to intermembrane space
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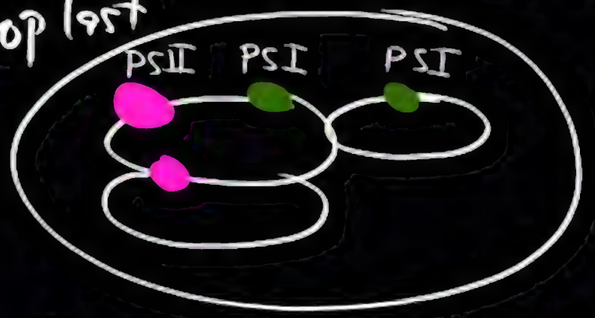
(a) two (b) three (c) Four (d) ten

Q10 Final $\bar{e}$ Acceptor in ETS is
(a) O_2 (b) Hydrogen (c) H_2O (d) all

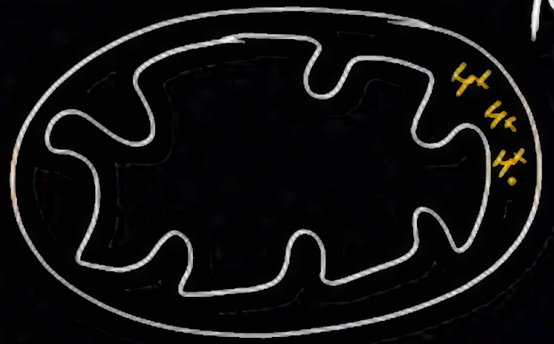
Comparison of chloroplast and Mitochondria

Chloroplast



F_0–F_1 (Chemiosmotic hypothesis)

Mitochondria



I H^+ Accumulate → thylakoid lumen → Intermembrane space

II $\bar{e}$ move with → light → oxidation of NADH & $FADH_2$
energy of ATP synthesis – Photo Phosphorylation → Oxidative phosphorylation

III $\bar{e}$ Come From → H_2O → NADH

IV Final $\bar{e}$ Acceptor → $NADP^+$ → O_2

Total ATP in Aerobic Respiration – From one Glucose

	ATP	NADH	Substrate level phosphorylating	oxidative phosphorylation	Total
Glycolysis	2	2	2	6 (2NADH x 3 ATP)	8 ATP
Link Reaction	0	1	0	3ATP X 2 link Rxn =	6 ATP
Krab cycle	1	3 (1 $FADH_2$)	1	11 → 3NADH = 9ATP, 1 $FADH_2$ = 2ATP = 11 ATP	12 ATP X 2 Krebs cycle = 24 ATP

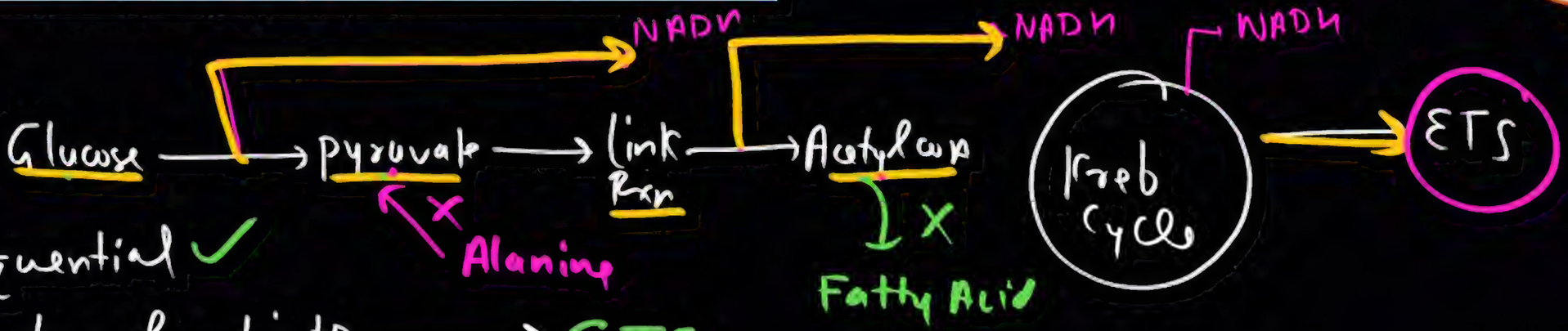
38 ATP

Calculation of ATP is theoretical Exercise

- It is only possible with some Assumptions

12.5 The Respiratory Balance Sheet

Assumptions:-



① – Sequential ✓

② NADH transferred into → ETS

③ No intermediate use to synthesise → Any other compound → All intermediate show Respiration

④ Respiratory Substrate → only Glucose (Acetyl CoA not come From Any other Source)

NET Gain of ATP — 38 or 36 ATP

Glycolysis ⟶ 2NADH Form ⟶ need to tranfer into Mitochondria

In cells two type of Shuttle System

(a) Malate Aspartate Shuttle ⟶ 2NADH Reach into Mitochondria → 6ATP → net gain - 38 ATP
(Heart, Liver, Kidney cells)

(b) Glycerol-3-phosphate Shuttle → 2NADH Reach into Mitochondria → 4ATP
(neurons & Muscle cells)
net gain - 36 ATP

Most cell → Glycerol-3-phosphate Shuttle Used

Respiratory pathway is Amphibolic

- Respiration process - Catabolic (Breakdown or Oxidation occur)

A Road B

- Respiratory pathways - Glycolysis, Krebs cycle → Amphibolic Pathway (Use in Biosynthesis as well as Breakdown)

Glucose (6C)

Gluconeogenesis (3 Extra Enzyme) ↑ | ↓ Glycolysis

Pyruvate (3C) X2

Catabolic ← | → Anabolic

Fatty Acid

Acetyl CoA

Krebs Cycle

α-Ketoglutarate (5C)

Anabolic →

Glutamic (5C) Acid

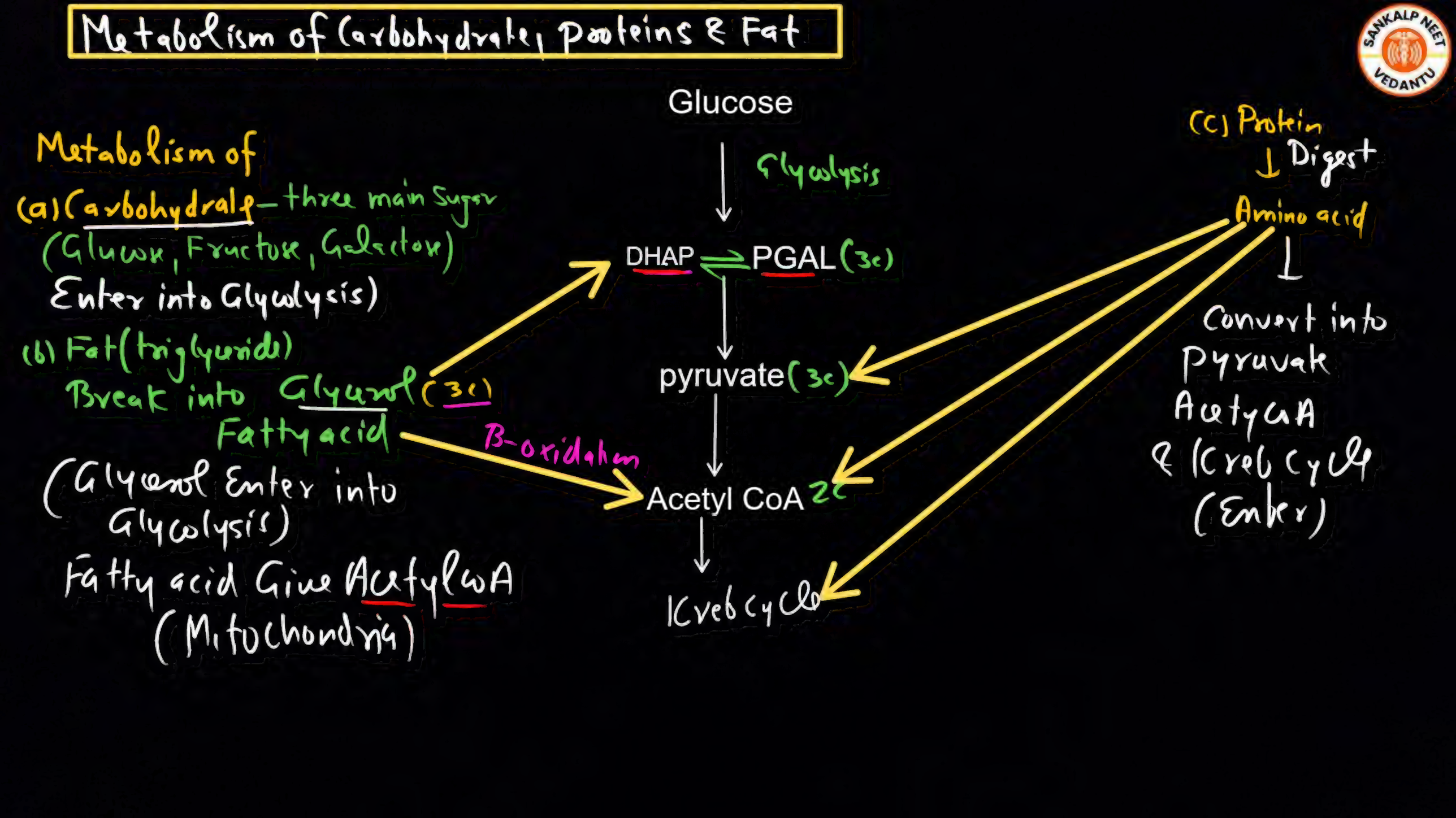
← Catabolic

Metabolism of Carbohydrate, Proteins & Fat

Metabolism of

(a) Carbohydrate – three main Sugar
(Glucose, Fructose, Galactose)
Enter into Glycolysis)

(b) Fat (triglyceride)
Break into Glycerol (3c)
Fatty acid
(Glycerol Enter into Glycolysis)
Fatty acid Give AcetylCoA
(Mitochondria)



(c) Protein
↓ Digest
Amino acid
↓
Convert into
Pyruvate
AcetylCoA
& Krebs cycle
(Enter)

Anaerobic Respiration

→ Glycolysis Common process → all type of cells

→ Pyruvate Fate (Future) depend on type of cell, type of Respiration

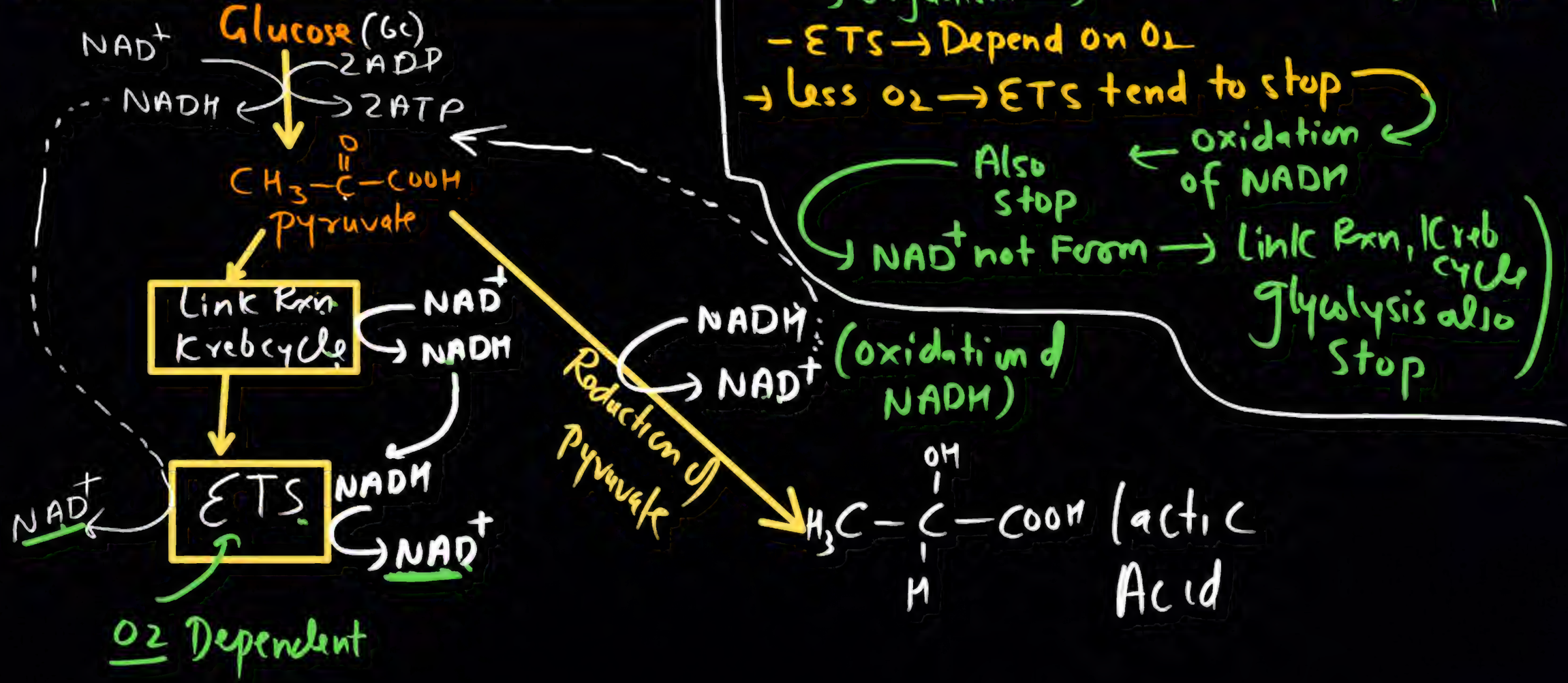
(a) Aerobic Respiration — Pyruvate complete oxidation
| Pyruvate to $3CO_2$ Form, O_2 use in ETS

(b) lactic Acid Fermentation → (a) Bacteria (lactobacci lus)
(b) Muscle cell (Limited O_2 Supply)

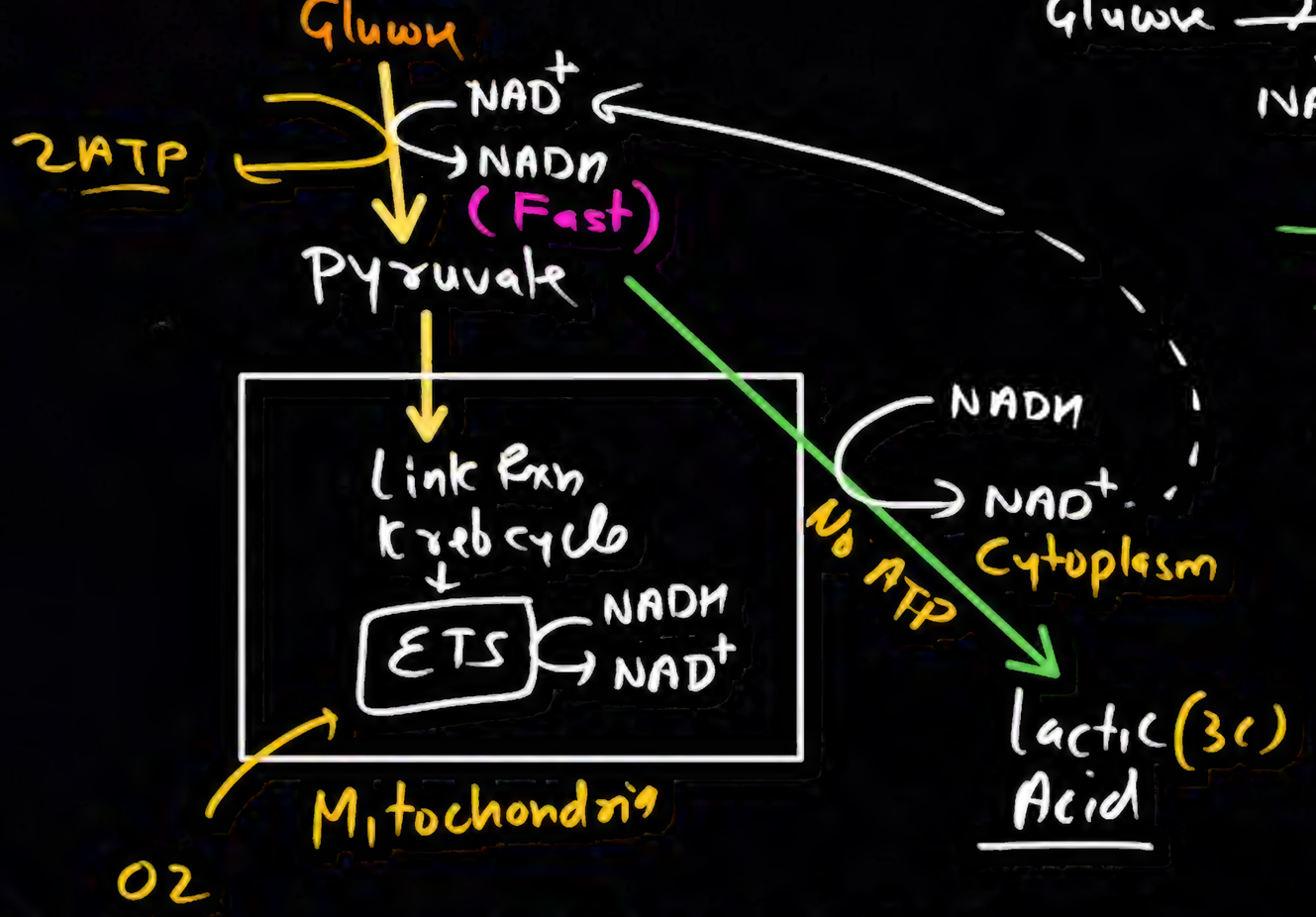
(c) Alcohol Fermentation → Yeast (Eukaryotes)
(Ethanol
Some bacteria

Lactic Acid Fermentation

location — Cytoplasm
Enzyme → lactate dehydrogenase
Organism →



- ETs → Depend on O_2
→ less O_2 → ETs tend to stop
← oxidation of NADH
Also stop
→ NAD^+ not Foorm → Linlc Rxn, lCreb cycle
Glycolysis also Stop



Glucose → (2 ATP) Pyruvate → lactic Acid

(2 ATP Form; NADH Form; NADH use (Enzyme - lactate dehydrogenase))

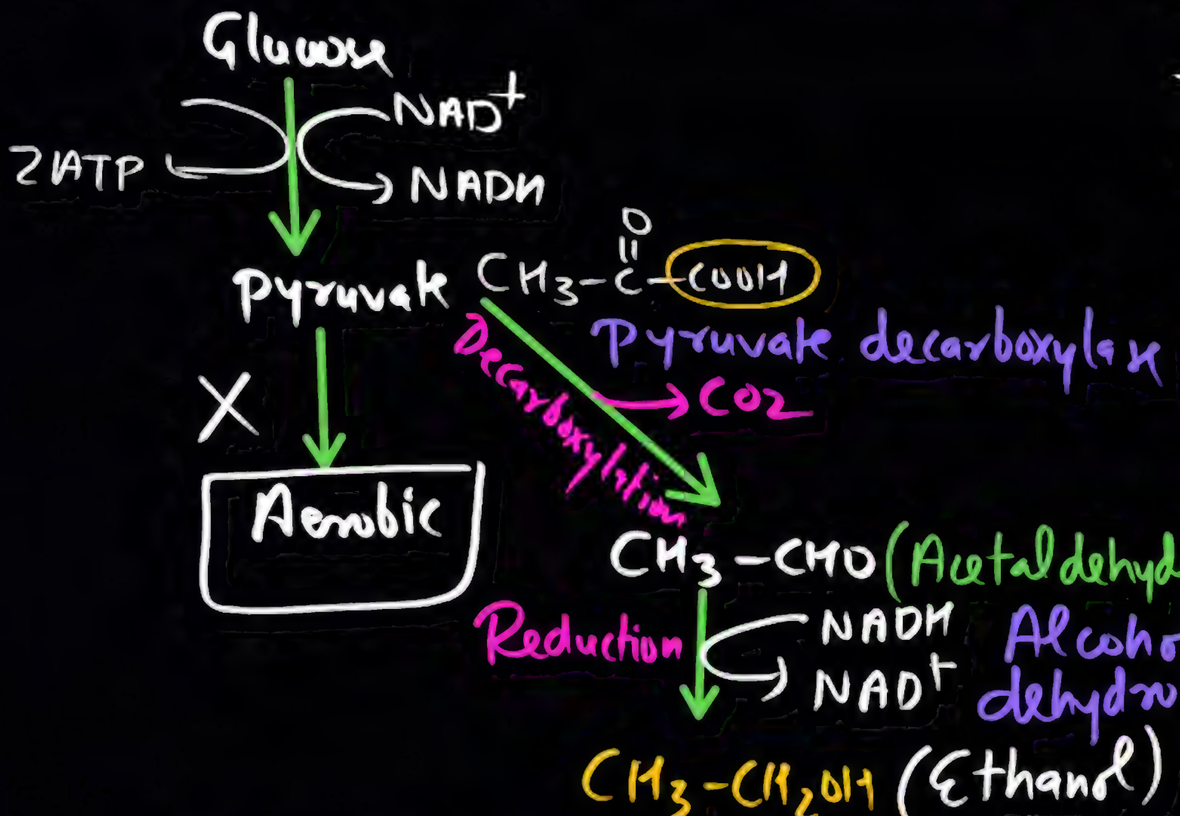
- CO_2 produce – No
- ATP Form → 2 ATP (less than 7% Energy)

→ Red Muscle → O_2 store (Myoglobin)
(ETS countinue, No lactic Acid)
(Marathon Runner, Flight muscle)

→ White muscle → No O_2 store
(O_2 less → lactic Acid Form)
(Present in sprinter)

Speed → Glycolysis (Fastest) > Aerobic (O_2 dependent) > lactic Acid (Anaerobic)

Ethanol Fermentation (Yeast - Saccharomyces cerevisiae - Brewer's Yeast)



- Location - Cytoplasm ✓
- Condition → O_2 Absent ✓
- Enzymes → Pyruvate decarboxylase, Alcohol dehydrogenase (Zn^{+2} Require)
- Product → pyruvate → (CO2) Acetaldehyde (2C) → Ethanol (2C)
  - → Ethanol, CO_2 [Regenrate → NAD^+ So that Glycolysis occur]
- ATP - 2ATP (Glycolysis)

Fermentation Ethanol → 13% → Yeast Starve to death itself (Higher conc. of Ethanol By Distillation)

Ethanol Fermentation

Substrate — Pyruvate → Ethanol (2c)

location → Cytoplasm

Enzyme → Pyruvate decarboxylase
Alcohol dehydrogenase

Process → decarboxylation
Reduction (NADH use)

CO_2 → $1(CO_2)$ | Pyruvate

ATP → 2 ATP (Glycolysis)

→ Prokaryotes
Eukaryotes → Absence of O_2

Lactic Acid Fermentation

Pyruvate to lactic Acid

Cytoplasm

lactate dehydrogenase

Reduction (NADH use)

→ No CO_2

→ 2 ATP (Glycolysis)

→ limited supply of O_2 (Eukaryotes (muscle)
Prokaryotes)

Respiratory Quotient

→ Carbohydrate, proteins, Fat & organic Acid → Can be used as a Respiratory Substrate

→ O_2 use, CO_2 Evolved in Respiration

$$RQ = \frac{\text{Volume of } CO_2 \text{ Evolve}}{\text{Volume of } O_2 \text{ Absorb}}$$ ⟵ Value depend on Respiratory Substrate

Example → $C_6H_{12}O_6$ → Carbohydrate ⟶ $C = O$ → nearly Equal (less O_2 Require) For Respiration

$C_{35}H_{50}O_2$ + Fatty Acid → $C < O$ → Difference (More O_2 Require)

Carbohydrate - RQ = 1

Fat ⟶ RQ = 0.7 (Ex - tripalmitin - Fatty acid

Protein → RQ = 0.9

Carbohydrate → 1

Fat / Fatty acid – 0·7

Protein / Amino Acid – 0·9

Some Organic Acid – More than 1
(Oxalic Acid)

Anaerobic Respiration

O_2 = Zero

⇉ Evolve CO_2 → ⇉ infinity

O_2 Absorb → Zero

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Plant Growth and development

lecture - 01

Botany

TARUN SIR

Today's Goal

- Plant Growth ✓
- Differentiation ✓
- Development ✓

What is Growth

→ Growth is Irreversible increase in number, Size of organ and cells

Features :- Fundamental process – occur in all organism

→ Conspicuous – Visible or measure

→ Irreversible (Wood —gn→ water → Swell (Reversible)]

→ Growth Require Energy ⟶ Catabolism
Some Biosynthesis of cell material → Anabolism] Both occur
Anabolism > Catabolism

note – Plant Show Unlimited Growth → Indeterminate
Plant Part – Leaf → Size After Some time Fix → determinate

Topics

← No. of Question → 3-4 Q

1 Growth 2 Q-Hormones

Growth
Differentiation
development
] 1 Topic I

[Plant Growth Regulator] 2 Topic-02

Photoperoidism
Venalization
Dormancy
] X Delete 4

Growth is regarded as one of the most fundamental and conspicuous characteristics of a living being. What is growth? Growth can be defined as an irreversible permanent increase in size of an organ or its parts or even of an individual cell. Generally, growth is accompanied by metabolic processes (both anabolic and catabolic), that occur at the expense of energy. Therefore, for example, expansion of a leaf is growth. How would you describe the swelling of piece of wood when placed in water? not Growth

Person is — Reversible

Feature of Plant Growth

(a) Plant initially → Root, stem and leaf Form ⟶ vegetative Growth

(b) Plants have Meristem (Dividing cells) ⟶ countinue to Divide → new cells Add

Such Growth is known as Open Growth

(c) Plant Growth two type → Primary Growth – Apical → Elongation Meristem (length Inc.)

Present in Dicot → Girth Inc. → Secondary Growth

((ateral Meristem)

& Gymnosperm

location of Plant Growth

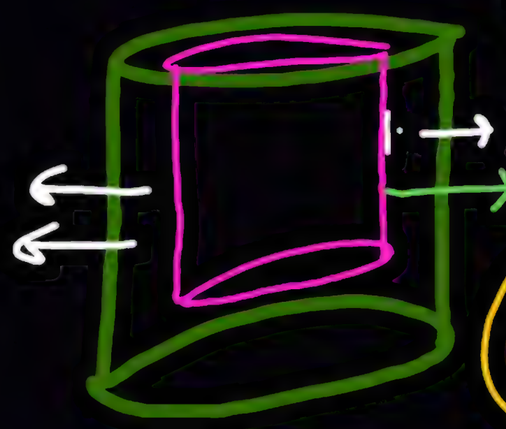
Shoot Apical Meristem

Root Apical Meristem

(Elongation along Axis)

Length Inc. → Primary Growth

– Leaf, Branch Form



Dicot stem, Dicot Root

Glymnostem

Secondary Meristem → Divide & increase Girth → Secondary Growth

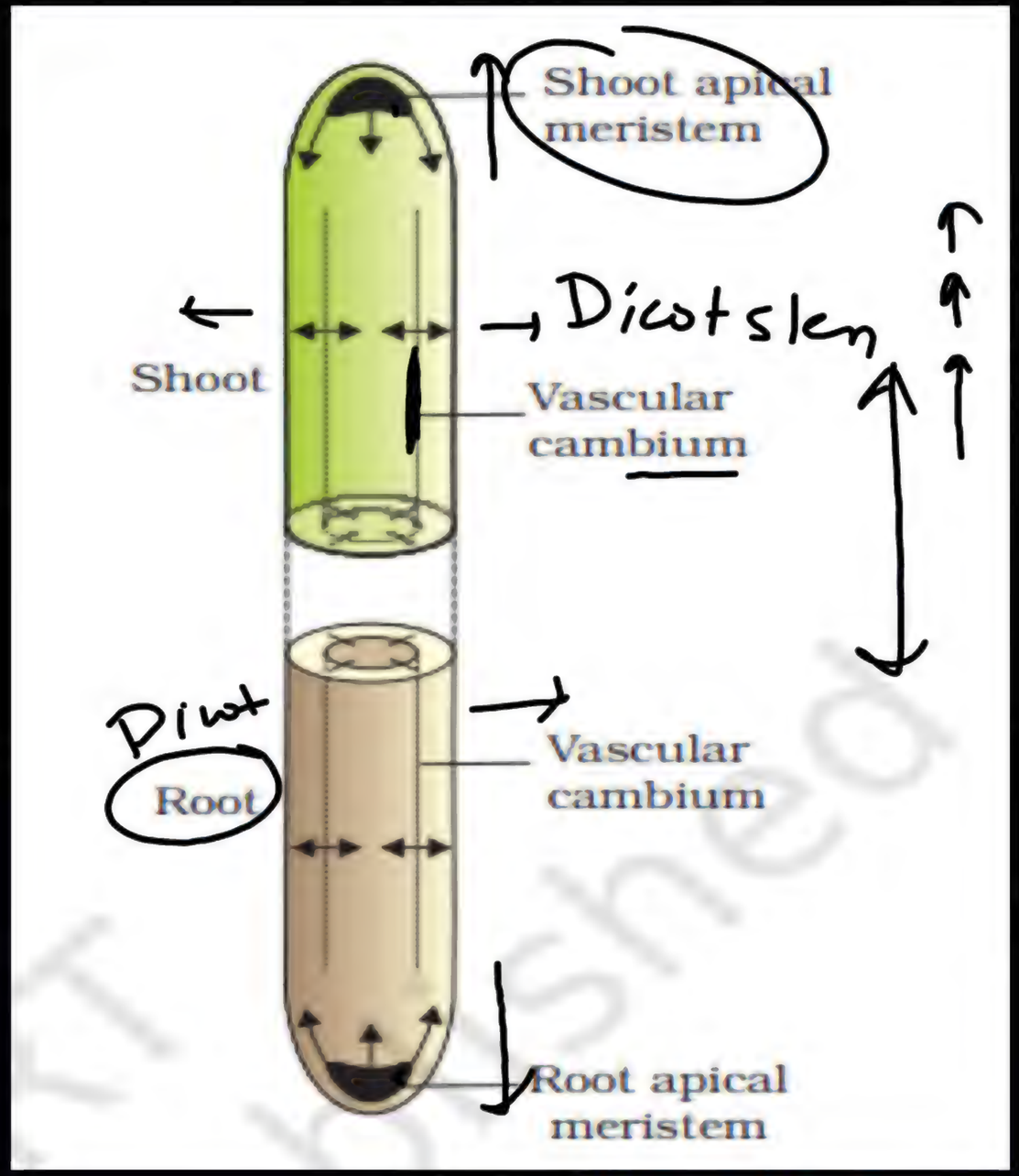
(Vascular cambium

Cork Cambium)

15.1.1 Plant Growth Generally is Indeterminate

Plant growth is unique because plants retain the capacity for unlimited growth throughout their life. This ability of the plants is due to the presence of meristems at certain locations in their body. The cells of such meristems have the capacity to divide and self-perpetuate. The product, however, soon loses the capacity to divide and such cells make up the plant body. This form of growth wherein new cells are always being added to the plant body by the activity of the meristem is called the open form of growth. What would happen if the meristem ceases to divide? Does this ever happen?

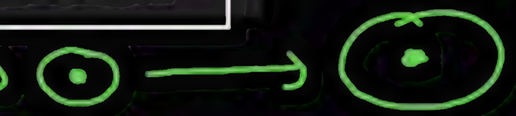
In Chapter 6, you have studied about the root apical meristem and the shoot apical meristem. You know that they are responsible for the



primary growth of the plants and principally contribute to the elongation of the plants along their axis. You also know that in dicotyledonous plants and gymnosperms, the lateral meristems, vascular cambium and cork-cambium appear later in life. These are the meristems that cause the increase in the girth of the organs in which they are active. This is known as secondary growth of the plant (see Figure 15.2).

How to measure Growth

- Main cause/Reason of Growth → Cytoplasmic Increase



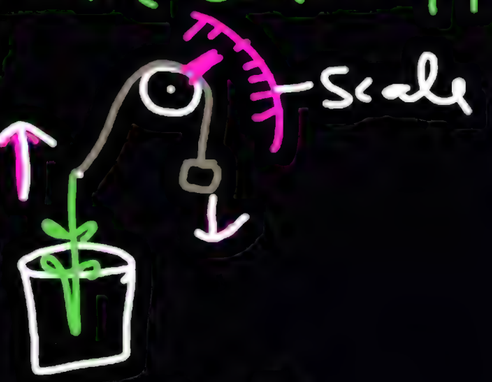
It is Difficult to measure cytoplasmic increase

We measure Quanity proportional to this

Example – we measure

(a) Inc. in Fresh wt / dry wt ✓
(b) Increase in Area ✓
(c) Inc. in volume ✓
(d) Inc. in weight ✓

(e) Inc in length (Auxanometer) instrument →



(f) leaf number inc.
(g) girth inc. For stem & Root

Ex – (a) Maize – Apical Meristem → 17,500 cells/hour → no. of cell Measure
(b) Watermelon → cells → volum → 3.5 lakh time Increase
(c) Pollen tube → length Inc.

15.1.2 Growth is Measurable

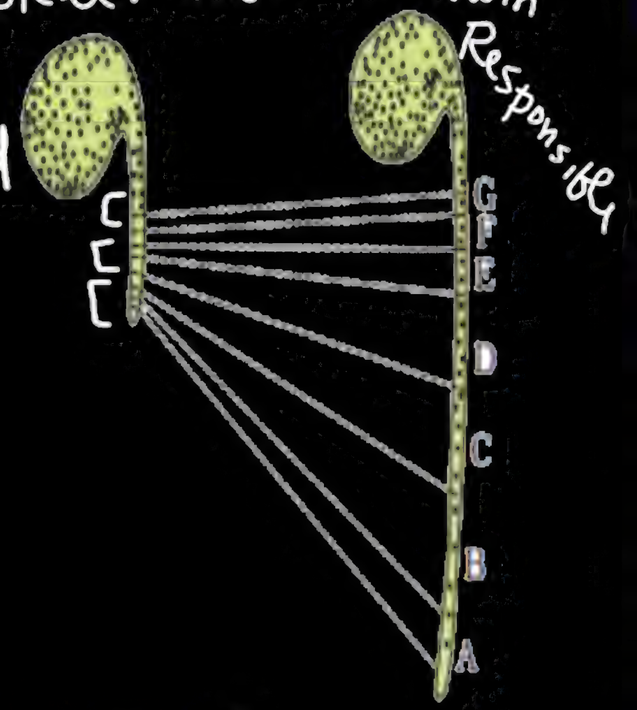
Growth, at a cellular level, is principally a consequence of increase in the amount of protoplasm. Since increase in protoplasm is difficult to measure directly, one generally measures some quantity which is more or less proportional to it. Growth is, therefore, measured by a variety of parameters some of which are: increase in fresh weight, dry weight, length, area, volume and cell number. You may find it amazing to know that one single maize root apical mersitem can give rise to more than 17,500 new cells per hour, whereas cells in a watermelon may increase in size by upto 3,50,000 times. In the former, growth is expressed as increase in cell number; the latter expresses growth as increase in size of the cell. While the growth of a pollen tube is measured in terms of its length, an increase in surface area denotes the growth in a dorsiventral leaf.

Phases of Growth

Growth occur Due to cells
Shoot Apex, Root Apex → Apical Meristem → Growth Responsible

Growth Divided into three phase

1. Meristematic → Meristem cells Dividing → Features
   Small size, protoplasm dense, cell wall primary, cell-Round
   Multiple plasmodesmata connection, no vacuole



Elongation → new all material From
→ Vacuolation start
→ Protoplasm inc.

Maturation → cell now Attain maximum size → not it become Permanent
→ Cell wall deposition complete
→ All changes in protoplasm complete
→ Vacuole maximum size

] no change in size

Cell wall – thin, primary

Nucleus – large – conspicuous

Plasmodesmata

new cell wall material

Protoplasm Inc.

Vacuolation start

— Cell is permanent

— Cell wall – changes Final deposition complete

Protoplasm – Final Chang

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meristematic zone represent the phase of elongation. Increased vacuolation, cell enlargement and new cell wall deposition are the characteristics of the cells in this phase. Further away from the apex, i.e., more proximal to the phase of elongation, lies the portion of axis which is undergoing the phase of maturation. The cells of this zone, attain their maximal size in terms of wall thickening and protoplasmic modifications. Most of the tissues and cell types you have studied in Chapter 6 represent this phase.

15.1.3 Phases of Growth

The period of growth is generally divided into three phases namely, meristematic, elongation and maturation (Figure 15.3). Let us understand this by looking at the root tips. The constantly dividing cells both at the root apex and the shoot apex represent the meristematic phase of growth. The cells in this region are rich in protoplasm, possess large conspicuous nuclei. Their cell walls are primary in nature, thin and cellulosic with abundant plasmodesmatal connections. The cells proximal (just next, away from the tip) to the

Growth Rate

- Growth per unit time — Growth Rate (Mainly → no. of cell Inc. / time → Growth Rate measure)
  Cell no. increase
  Can be use to measure Growth rate
- Two type of Growth Rate →
  (a) Arthimatic Growth Rate
  (b) Geometeric Growth Rate

15.1.4 Growth Rates

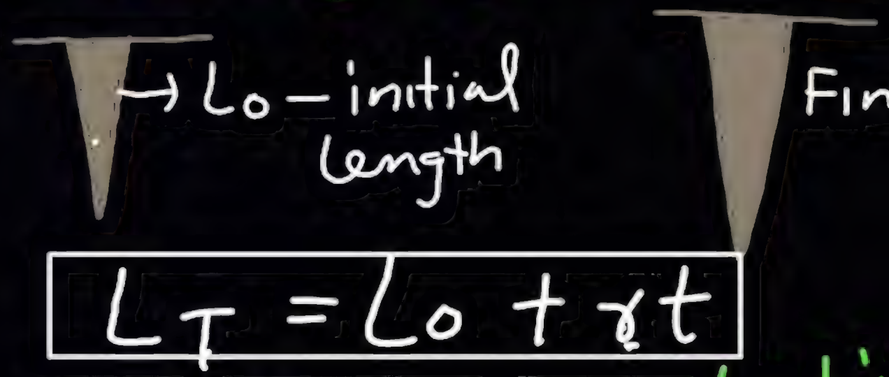
The increased growth per unit time is termed as growth rate. Thus, rate of growth can be expressed mathematically. An organism, or a part of the organism can produce more cells in a variety of ways.

Arthematic Growth Rate

- When cell Divide → only one cell out of two Daughter cell Countinue to Divide

1 cell → 2 cell → 3 cell → 4 cell → 5 cell

Example → length of Root ✓



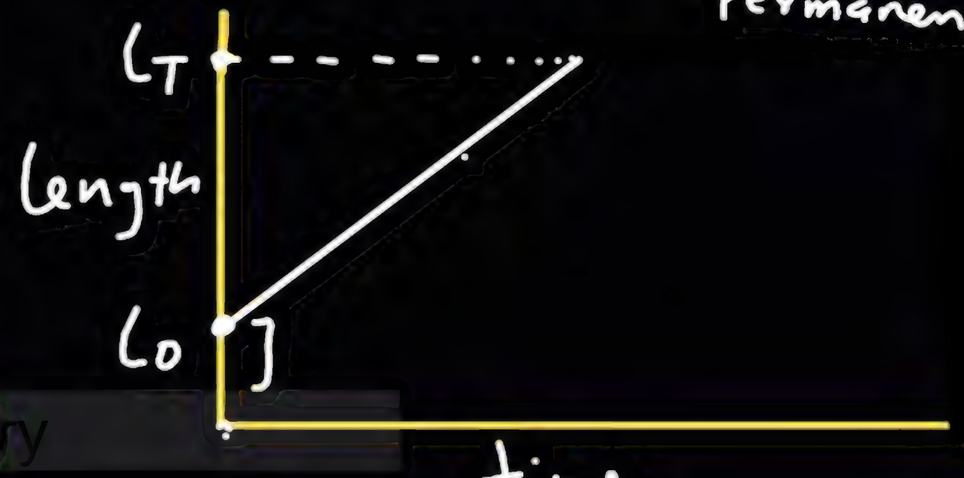
$$L_T = L_o + \gamma t$$

t = time

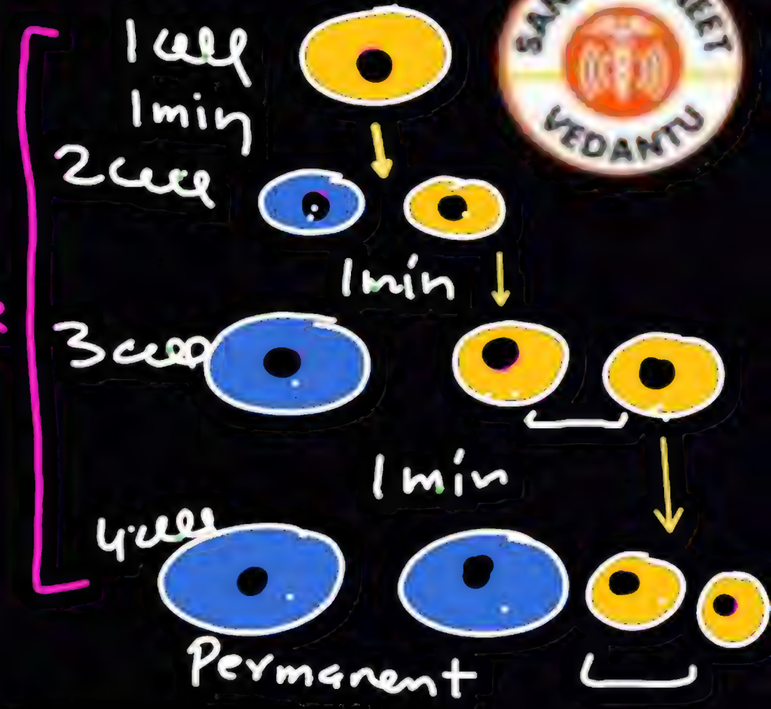
L_T = Final length

L_o – initial length

γ = Arthimetic Growth rate (Constant)



$\frac{1 \text{ cell}}{\text{min}} = \gamma$ rate



The growth rate shows an increase that may be arithmetic or geometrical (Figure 15.4).

In arithmetic growth, following mitotic cell division, only one daughter cell continues to divide while the other differentiates and matures. The simplest expression of arithmetic growth is exemplified by a root elongating at a constant rate. Look at Figure 15.5. On plotting the length of the organ against time, a linear curve is obtained. Mathematically, it is expressed as

$$L_t = L_0 + rt$$

L_t = length at time 't'

L_0 = length at time 'zero'

r = growth rate / elongation per unit time.

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Geometric Growth Rate

- one cell Divide into two Daughter cell → Each cell continue to Divide

Ex- Most organism – nature – Similar growth show

most tissue show this Growth

W_T – Final weight

W_0 = initial weight

r = Geometeric Growth rak

(Efficiency index – By which Rate new tissue From

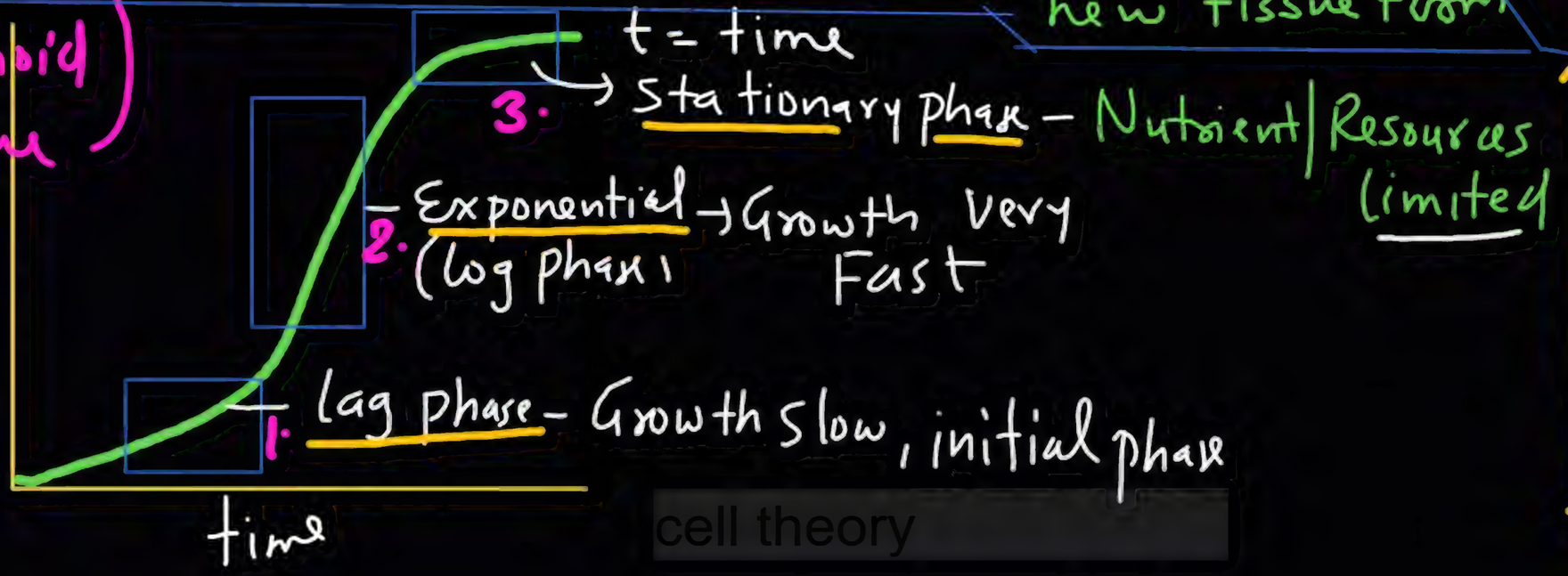
$$W_T = W_0 e^{rt}$$

t = time

e = base of natural logarithm

1 cell → 1 min → 2 cell → 1 min → 4 cell

(Sigmoid Curve)



3. → Stationary phase – Nutrient / Resources limited

2. Exponential (log phase) → Growth very Fast

1. lag phase – Growth slow, initial phase

Three phase observe in Exponential Growth

cell theory

Let us now see what happens in geometrical growth. In most systems, the initial growth is slow (lag phase), and it increases rapidly thereafter – at an exponential rate (log or exponential phase). Here, both the progeny cells following mitotic cell division retain the ability to divide and continue to do so. However, with limited nutrient supply, the growth slows down leading to a stationary phase. If we plot the parameter of growth against time, we get a typical sigmoid or S-curve (Figure 15.6). A sigmoid curve is a characteristic of living organism growing in a natural environment. It is typical for all cells, tissues and organs of a plant. *Can you think of more similar examples? What kind of a curve can you expect in a tree showing seasonal activities?*

The exponential growth can be expressed as

and organs of a plant. *Can you think of more similar examples? What kind of a curve can you expect in a tree showing seasonal activities?*

The exponential growth can be expressed as

$$W_1 = W_0 e^{rt}$$

W_1 = final size (weight, height, number etc.)

W_0 = initial size at the beginning of the period

r = growth rate

t = time of growth

e = base of natural logarithms

Here, r is the relative growth rate and is also the measure of the ability of the plant to produce new plant material, referred to as efficiency index. Hence, the final size of W_1 depends on the initial size, W_0.

Arthematic

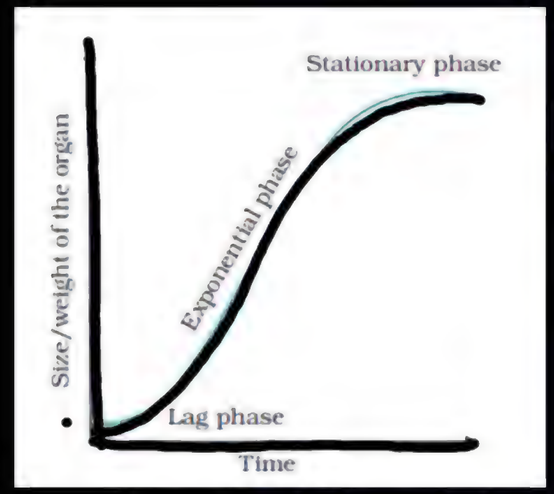
Equation – $L_T = L_0 + rt$

r = Artimatic Growth rate

location – Root

Graph + linear

Geometric



Equation → $W_T = W_0 e^{rt}$

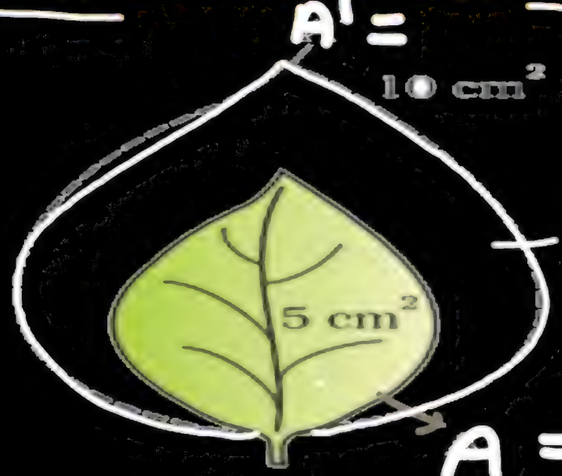
r = Geometeric Growth Rate / Efficiency index

location – most plant tissue

Graph – Sigmoid

cell theory

Absolute and Relative Growth



A' = 10 cm²

A = 5 cm²

Absolute Growth same

But Relating Growth Different

B' = After Growth 55 cm²

B = 50 cm²

	Leaf A	Leaf B
Absolute Growth (Final − initial)	$10-5 = 5\,cm^2$	$\Rightarrow 55-50 = 5\,cm^2$
Relative Growth $\frac{\text{Final}-\text{initial}}{\text{initial}} \times 100$	$\frac{10-5}{5} \times 100 \Rightarrow 100\%$	$\rightarrow \frac{55-50}{50} \times 100 = \frac{5}{50} \rightarrow \frac{1}{10} \rightarrow 10\%$

cell theory

Arthimatic Growth → 1 cell $\xrightarrow{1\,min}$ 2 cell $\xrightarrow{1\,min}$ 3 cell $\xrightarrow{1\,mn}$ 4 cell

✓ Absolute Growth – 2-1, 3-2, 4-3 ∃ 1 cell/min — Constant

Relative Growth → $\frac{2-1}{1}$, $\frac{3-2}{2}$, $\frac{4-3}{3}$ (decreasing)

Geometeric Growth → 1 cell $\xrightarrow{1\,min}$ 2 cell $\xrightarrow{1\,min}$ 4 cell → 8 cell

Absolute Growth → 2-1, 4-2, 8-4 → Increasing

Relative Growth → $\frac{2-1}{1}$, $\frac{4-2}{2}$, $\frac{8-4}{4}$ ∄ Constant

cell theory

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Plant Growth and development

lecture - 02

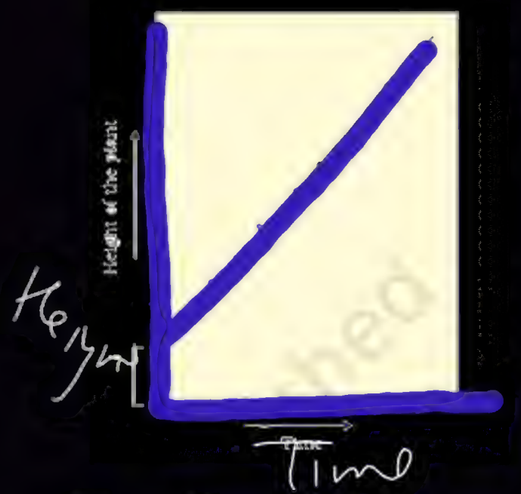
Botany

TARUN SIR

Today's Goal

- Differentiation
- Development
  - → Auxin
  - → Gibberlin

Arthematic



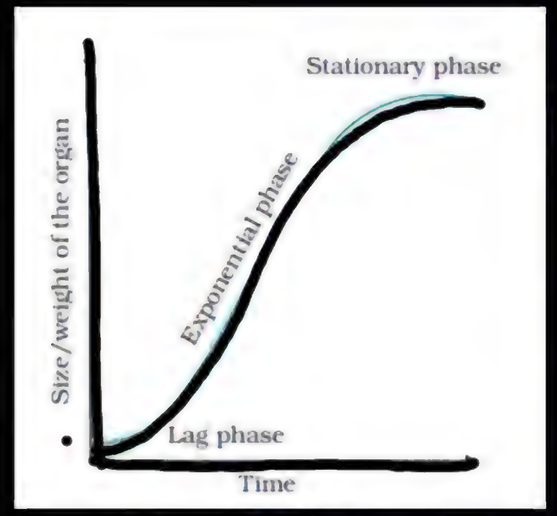
Equation - $L_T = L_0 + rt$

r = Artimatic Growth rate

location - Root

Graph + linear

Geometric



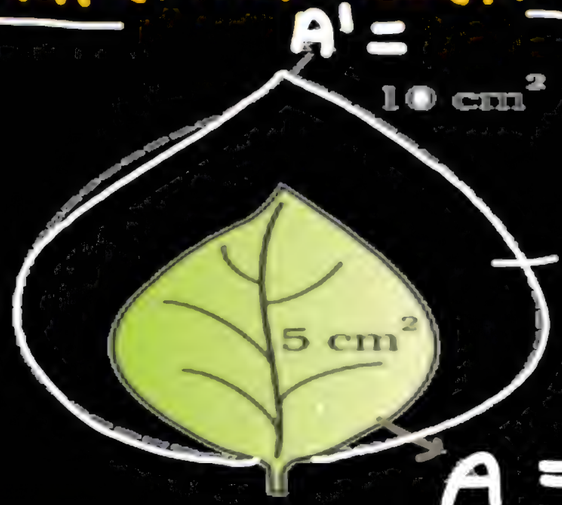
Equation → $W_T = W_0 e^{rt}$

r = Geometeric Growth Rate / Efficiency index

location - most plant tissue

Graph - Sigmoid

Absolute and Relative Growth



A = 5cm²

A' = 10cm²

Absolute Growth same

But Relative Growth Different

B' = After Growth

55 cm² 55 cm²

B = 50cm2

	Leaf A	Leaf B
Absolute Growth (Final − initial)	10 − 5 = 5cm²	⇒ 55 − 50 = 5cm²
Relative Growth $\frac{\text{Final} - \text{initial}}{\text{initial}} \times 100$	$\frac{10-5}{5} \times 100 \Rightarrow 100\%$	$\rightarrow \frac{55-50}{50} \times 100 = \frac{5}{50} \rightarrow \frac{1}{10} \rightarrow 10\%$

Arthimatic Growth → 1 cell —1min→ 2 cell —1min→ 3 cell —1mn→ 4 cell ✓

✓ Absolute Growth — 2-1 , 3-2 , 4-3 ∃ 1 cell/min — Constant

Relative Growth → $\frac{2-1}{1}$, $\frac{3-2}{2}$, $\frac{4-3}{3}$ (decreasing)

1 → .50 → .33

Geometeric Growth → 1 cell —1min→ 2 cell —1min→ 4 cell → 8 cell

Absolute Growth → 2-1 , 4-2 , 8-4 → Increasing

Relative Growth → $\frac{2-1}{1}$, $\frac{4-2}{2}$, $\frac{8-4}{4}$ ≠ Constant

Quantitative comparisons between the growth of living system can also be made in two ways : (i) measurement and the comparison of total growth per unit time is called the absolute growth rate (ii) The growth of the given system per unit time expressed on a common basis e.g., per unit initial parameter is called the relative growth rate. In Figure 15.7 two leaves, A and B, are drawn that are of different sizes but shows absolute increase in area in the given time to give leaves, A^1 and B^1. However, one of them shows much higher relative growth rate. Which one and why?

Condition For Growth → External Factors For plant factor

① water — make cell turgid (swell) → cell Growth occur → (Plant Growth ∝ water status of plant)
↳ Medium For Enzyme Activity

② oxygen → Require For Aerobic Respiration → ATP From
(help to make molecules/cellulose molecule For growth)

③ nutrients → From soil plants Obtain Mineral
Macronutrients → C, H, O, N, P, S, K
Micronutrients — Fe, Cu, Ni, Mo, B, Cl, Mn

Other Factor

temperature — optimum temp. For Enzyme
Gravity → Geotropism → Root move into soil
Light → Phototropism
↳ Flowering

15.1.5 Conditions for Growth

Why do you not try to write down what you think are necessary conditions for growth? This list may have water, oxygen and nutrients as very essential elements for growth. The plant cells grow in size by cell enlargement which in turn requires water. Turgidity of cells helps in extension growth. Thus, plant growth and further development is intimately linked to the water status of the plant. Water also provides the medium for enzymatic activities needed for growth. Oxygen helps in releasing metabolic energy essential for growth activities. Nutrients (macro and micro essential elements) are required by plants for the synthesis of protoplasm and act as source of energy.

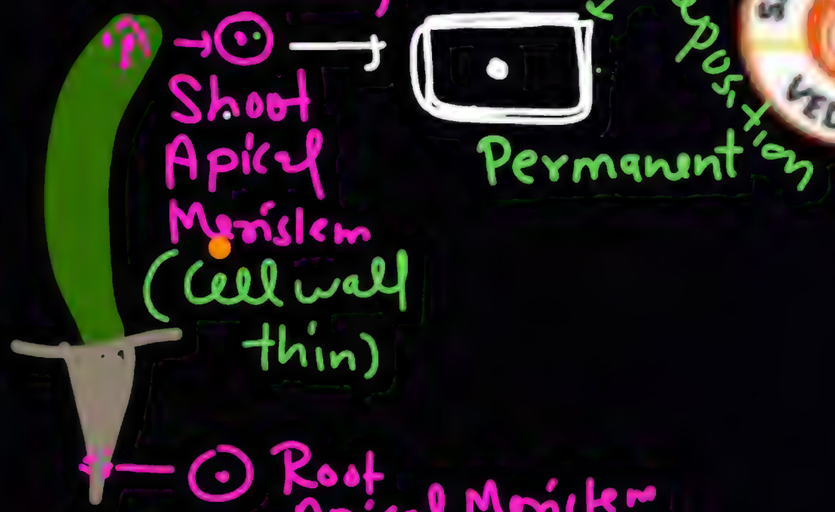
In addition, every plant organism has an optimum temperature range best suited for its growth. Any deviation from this range could be detrimental to its survival. Environmental signals such as light and gravity also affect certain phases/stages of growth.

Differentiation → Process

meaning – Cell loose capacity to Divide, it Become permanent
(Size Fix, Role Fix, all changes occurred)

Change → Protoplasm & cell wall

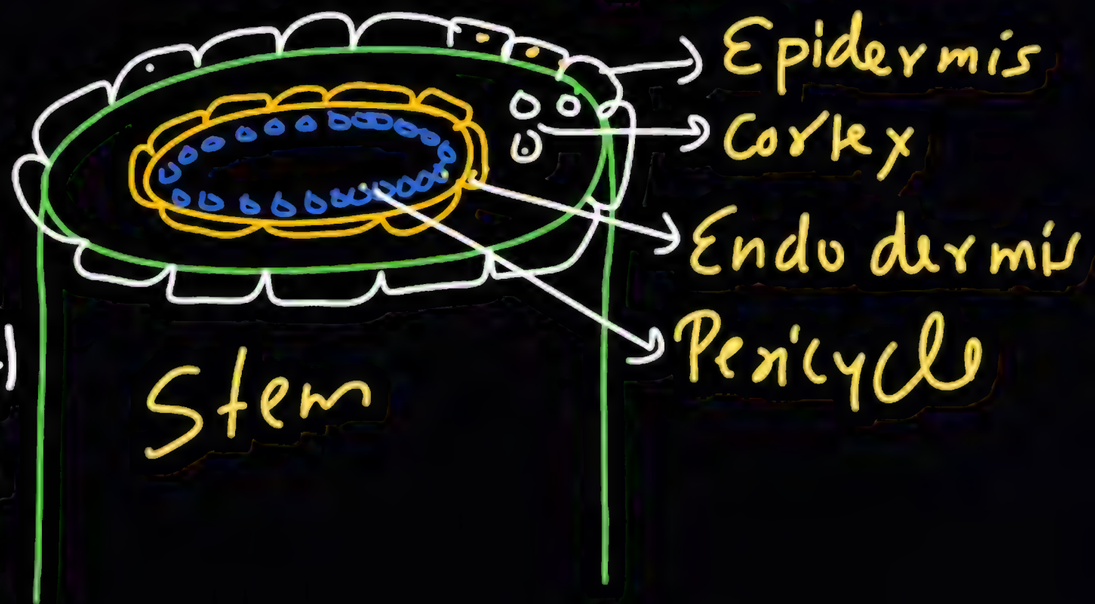
location – Shoot Apical, Root Apical (Dividing) → Convert into Permanent



type of cells From
- Epidermis → Primary
- Cortex → Xylem
- Endodermis → Primary
- Pericycle → Phloem

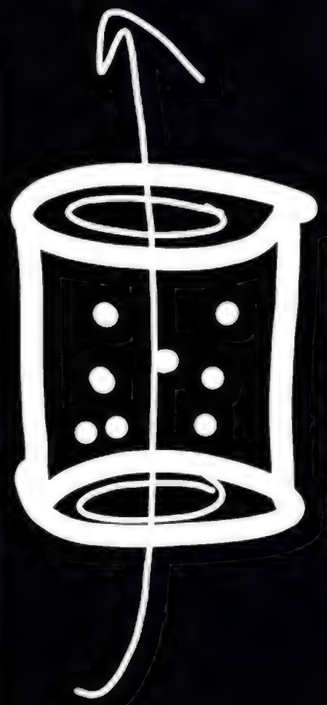
tissue

Tracheids (dead cells)
- No protoplasm
- Wall - lignified



Differentiation

The cells derived from root apical and shoot-apical meristems and cambium differentiate and mature to perform specific functions. This act leading to maturation is termed as **differentiation**. During differentiation, cells undergo few to major structural changes both in their cell walls and protoplasm. For example, to form a tracheary element, the cells would lose their protoplasm. They also develop a very strong, elastic, lignocellulosic secondary cell walls to carry water to long distances even under extreme tension. Try to correlate the various anatomical features you encounter in plants to the functions they perform.



Dedifferentiation

(Permanent → Dividing (Meristem)

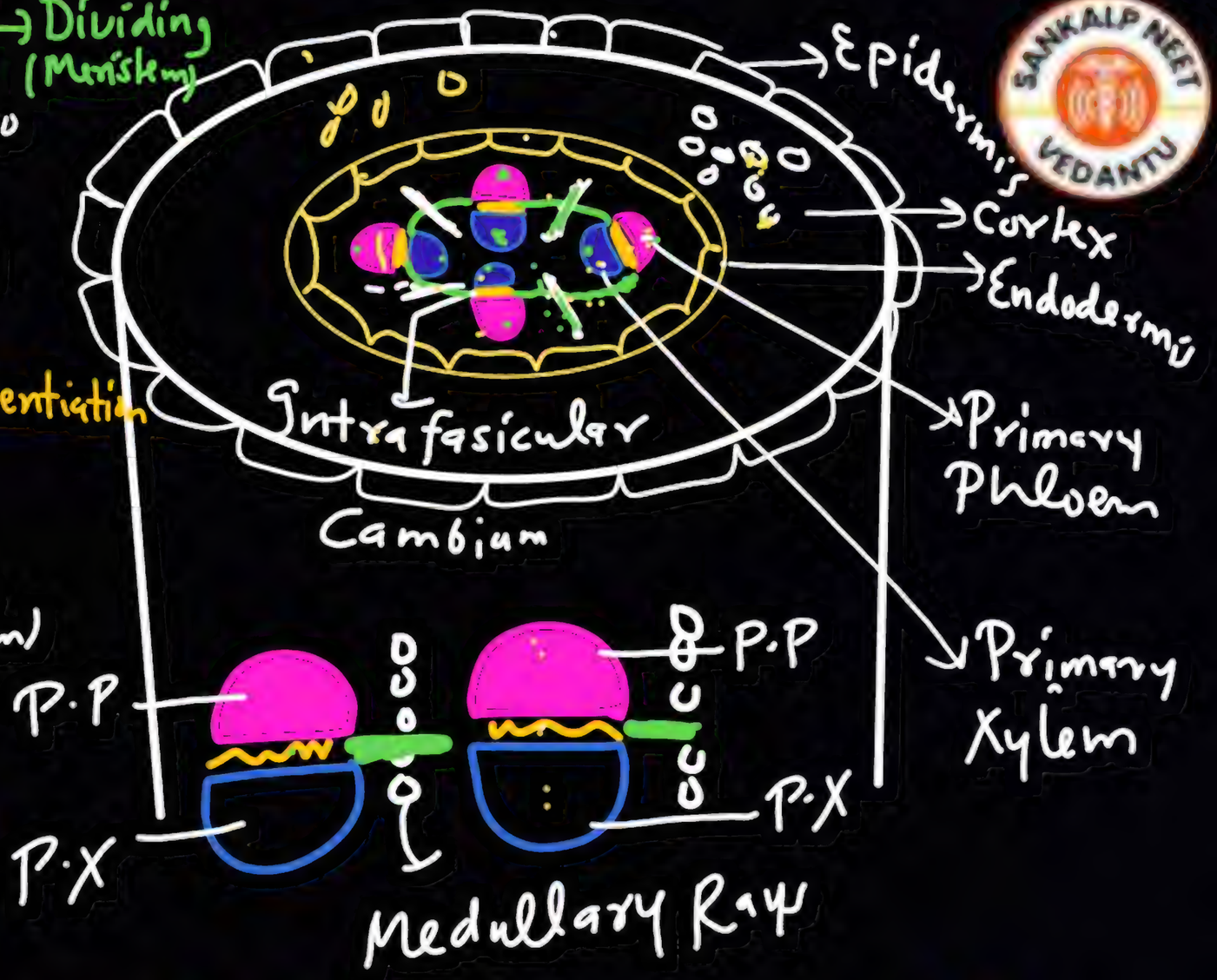
→ Permanent cell Generally loose capacity to Divide

→ Some permanent cell → Again gain Ability to Divide

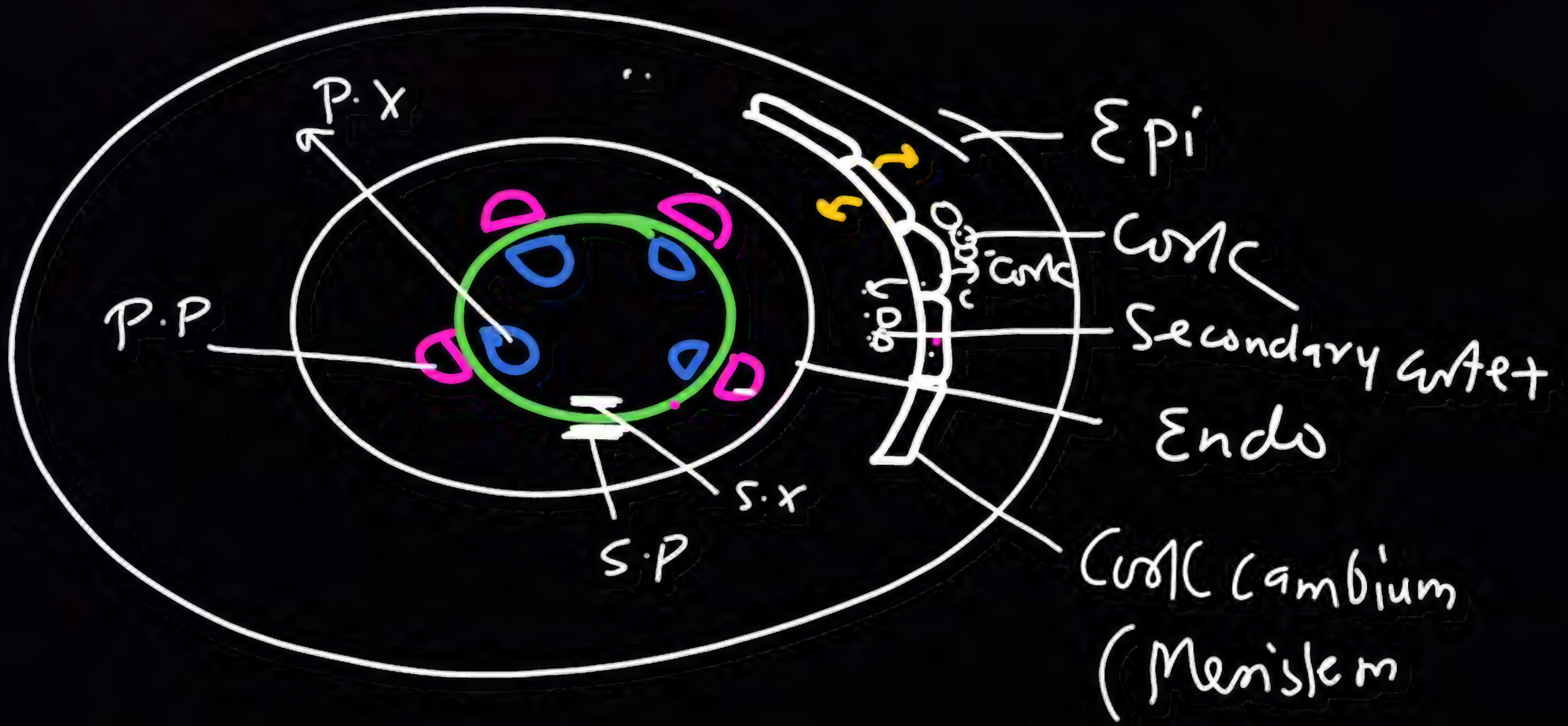
By Process – Dedifferentiation

Cortex (Permanent) —de differentiation→ Cork Cambium (Meristem)

Medullary Rays —Dedifferentiation→ Vascular Cambium



note - Meristem develop From permanent cell By Process of Dedifferentiation Known as → Secondary Meristem


P.X
P.P
S.X
S.P
Epi
Cortex
Cortex
Secondary cortex
Endo
Cortex cambium
(Meristem

Plants show another interesting phenomenon. The living differentiated cells, that by now have lost the capacity to divide can regain the capacity of division under certain conditions. This phenomenon is termed as **dedifferentiation**. For example, formation of meristems – interfascicular

Rediferentiation

Vascular cambium
(Secondary Meristem)

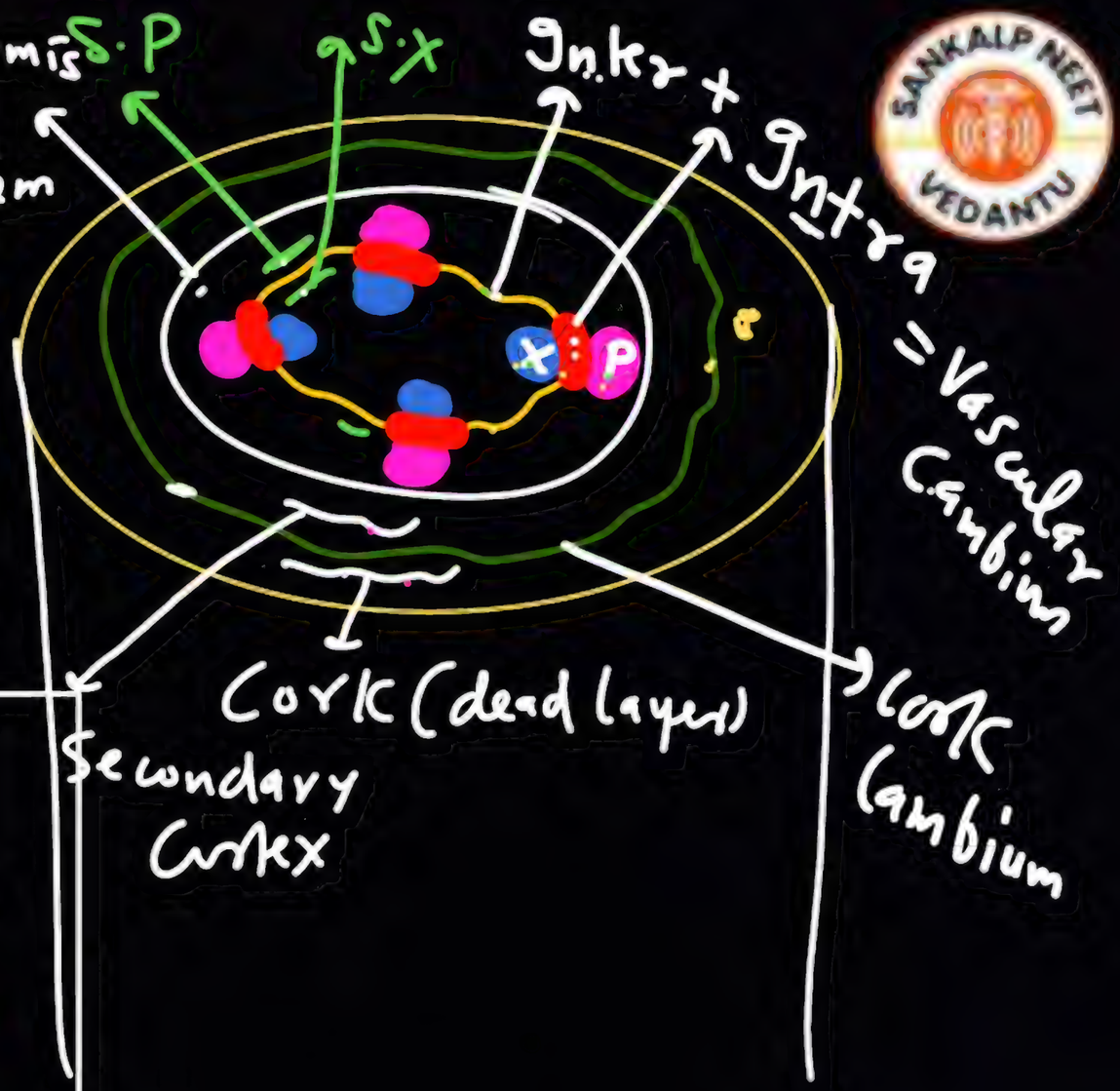
Cells Become Permanent → Secondary Xylem, Secondary Phloem

Rediferentiation

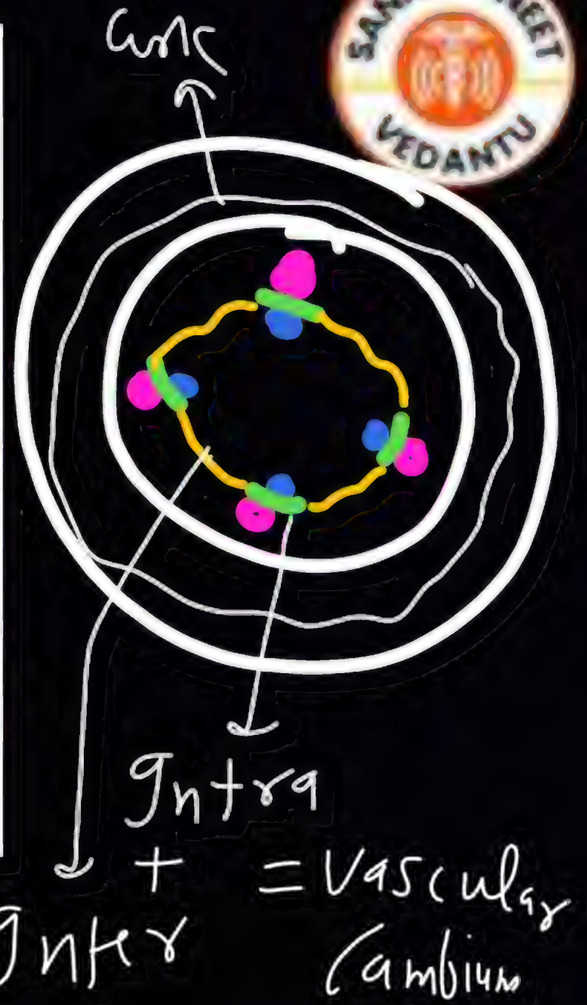
(Phellogen)
Cork Cambium
(Secondary Meristem)

Rediferentiation → Cork, Secondary Cortex

Primary Meristem → (Differentiation) → Primary tissue → some cell ↓ Dediferentiation → (U.C, C.C) Secondary Meristem → Rediferentiation → Permanent cells (Secondary tissue)



dedifferentiation. For example, formation of meristems – interfascicular cambium and cork cambium from fully differentiated parenchyma cells. While doing so, such meristems/tissues are able to divide and produce cells that once again lose the capacity to divide but mature to perform specific functions, i.e., get **redifferentiated**. List some of the tissues in a woody dicotyledenous plant that are the products of redifferentiation. How would you describe a tumour? What would you call the parenchyma cells that are made to divide under controlled laboratory conditions during plant tissue culture?

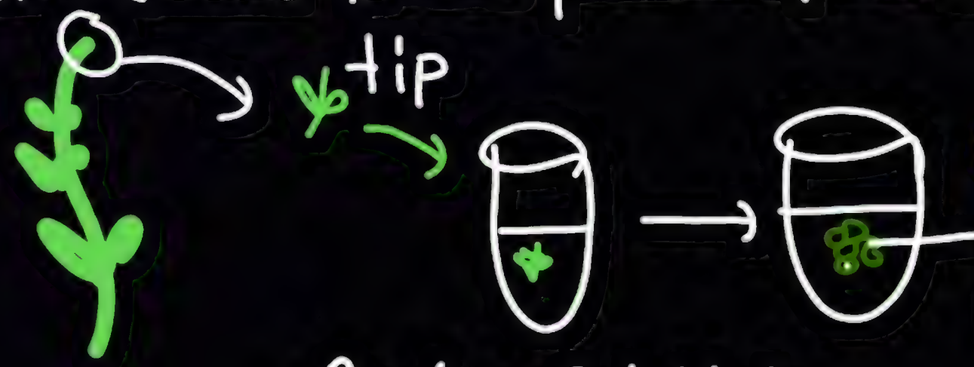


Tissue Undergo	Process (Undergo) | Product	Result in (tissue Form
① Apical Meristem	Differentiation	Epidermis, Endodermis, Cortex, Primary Xylem, Primary Phloem
② Cortex, Medullary Rays	→ Dedifferentiation	→ Cork cambium, Vascular cambium (Interfasicular) — Secondary Meristem
③ Cork cambium	→ Redifferentiation	→ Cork, Secondary cortex
Vascular cambium	→	→ Secondary Xylem, Secondary phloem

Q Cork cambium is product → DP]
Cork cambium undergo → RD]

Recall, in Section 13.1.1, we have mentioned that the growth in plants is open, i.e., it can be indeterminate or determinate. Now, we may say that even differentiation in plants is open, because cells/tissues arising out of the same meristem have different structures at maturity. The final structure at maturity of a cell/tissue is also determined by the location of the cell within. For example, cells positioned away from root apical meristems differentiate as root-cap cells, while those pushed to the periphery mature as epidermis. Can you add a few more examples of open differentiation correlating the position of a cell to its position in an organ?

note- Callus is also product of dedifferentiation



Auxin = Cytokinin (conc.)

(Darkness)

Callus

Mass of cells

(Dividing - Meristem)

(Secondary Meristem)

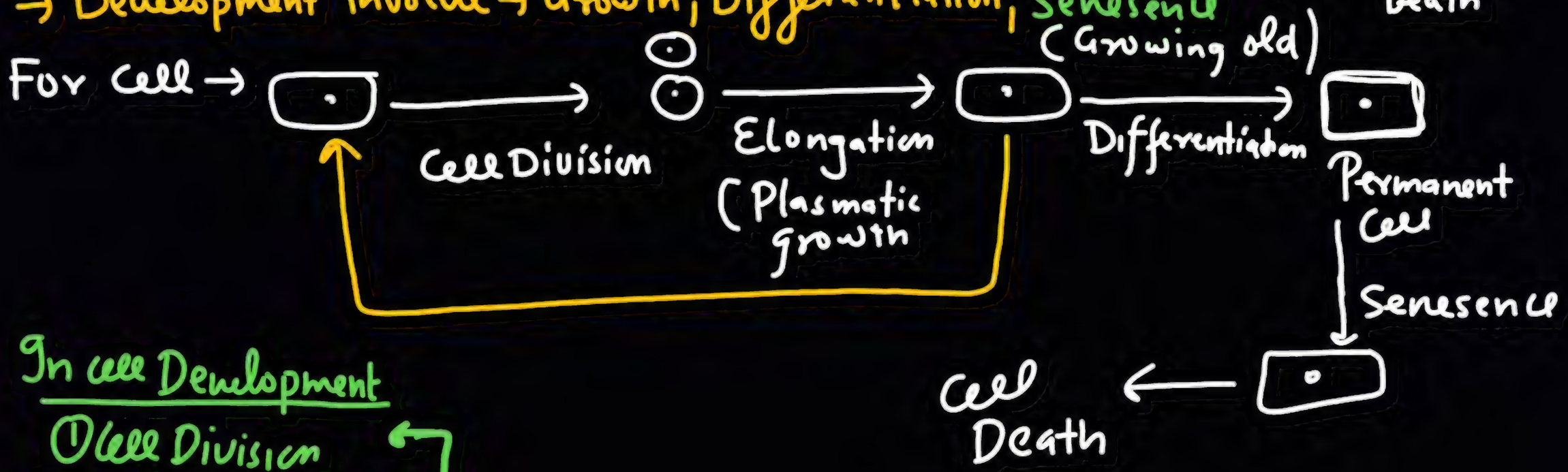
note - Plant Differentiation is open

(tissue Form on the Basis of Location)

Development

→ It involve all steps → Seed → Seed germination → Plant → Flower → Senescence → Death
Growth, Fruit

→ Development involve → Growth, Differentiation, Senescence



In cell Development

1. Cell Division
2. Cell Growth
3. Differentiation
4. Senescence

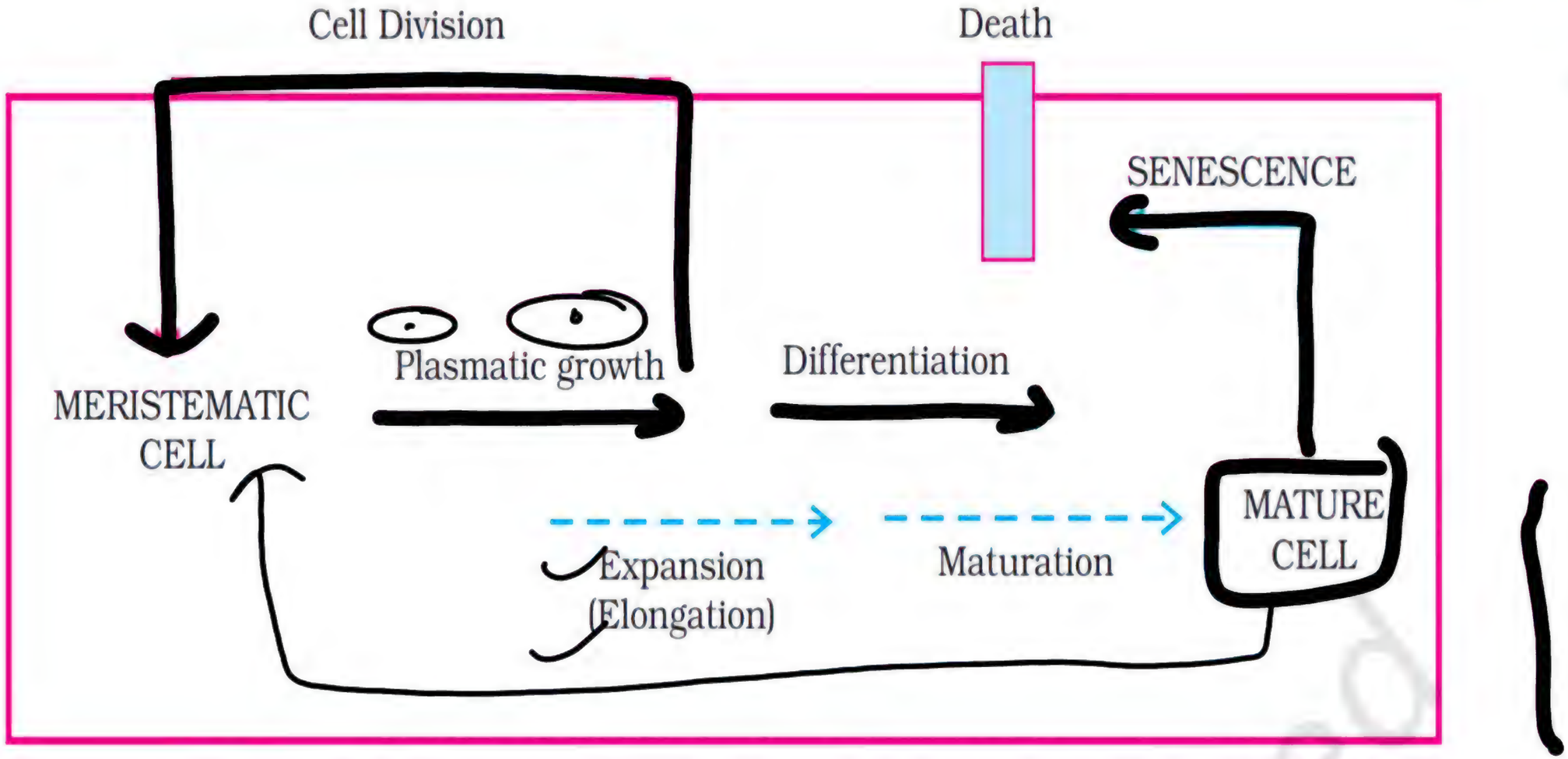


Figure 13.8 Sequence of the developmental process in a plant cell

15.3 Development

Development is a term that includes all changes that an organism goes through during its life cycle from germination of the seed to senescence. Diagrammatic representation of the sequence of processes which constitute the development of a cell of a higher plant is given in Figure 15.8. It is also applicable to tissues/organs.

Plasticity

Plants Acc. to Enviroment → Some behaviour show | Change in Growth pattern
or Different structure Form

Example of Plasticity — Hetero phylly (Hetero – Different
Phylly – Leaf

Two type of Heterophylly

(a) Developmental Heterophylly – During life cycle two type of leaf
Ex – Coriander, cotton, larakspur

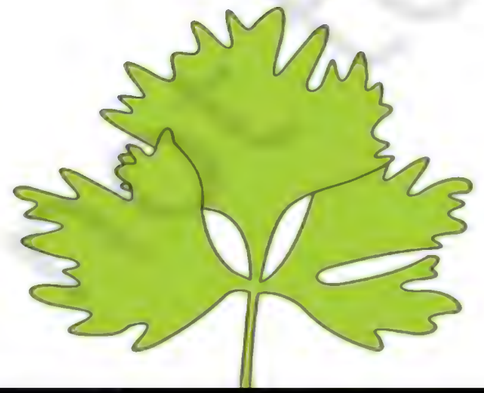
(b) Enviromental Heterophylly → Ex – Buttercup
Different leaf in Aquatic & terrestial)

Plants follow different pathways in response to environment or phases of life to form different kinds of structures. This ability is called **plasticity,** e.g., heterophylly in cotton, coriander and larkspur. In such plants, the leaves of the juvenile plant are different in shape from those in mature plants. On the other hand, difference in shapes of leaves produced in air and those produced in water in buttercup also represent the heterophyllous development due to environment (Figure 13.9). This phenomenon of heterophylly is an example of plasticity.

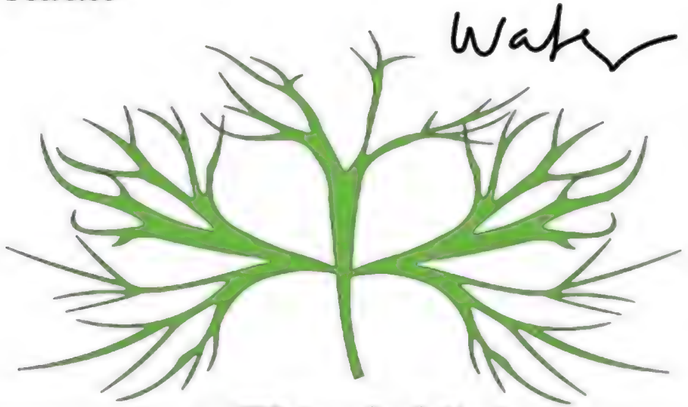
Juvenile

Adult

(a)



land



Water

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Plant Growth and development

lecture - 03

Botany

TARUN SIR

Today's Goal

- Plant Hormones

Factors controlling Growth and development

Factors

Extrinsic / External

- → Light
- → temp.
- → Water
- → nutrients

Affect Growth & Development

Intrinsic — two type

(a) Intracellular – inside cell
Growth Affect – Genes

(b) Intercellular – B/w two cells

Ex – Plant Growth Hormone

Q PGR are
(a) intrinsic intracellular (b) Extrinsic (c) Inorganic (d) Intrinsic Intrinsic Intercellular

What are plant Hormones

Other name – Phytohormone | Plant Growth Regulators

Examples:- Auxin, Gibberlic Acid, Cytokinin, Ethylene, Abscissic Acid

Feature:- (a) Group of chemicals – name on the Basis of common Function

(b) Simple molecule ✓

(c) organic ✓ (d) Diverse chemical nature

(e) Act on tissue produce them or Away From them

(f) all Are Acidic in nature (Except Cytokinin) → It is a purine

Indole Ring
(tryptophan)

Indole Acetic Acid
Indole Butyric Acid
} Auxin

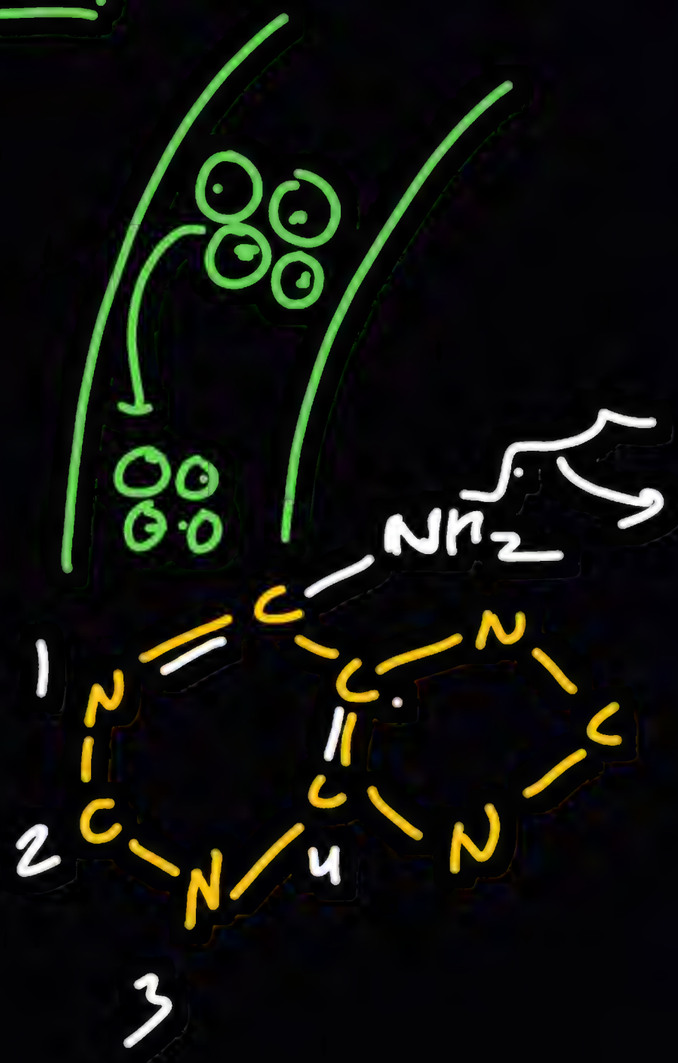
Auxin → Indole compound Derivative

Gibberlic Acid + terpene

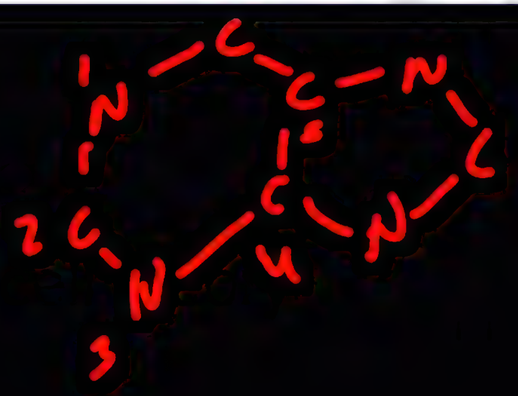
Cytolcinin – Purine derivative

Ethylene - Gaseous Hormone

Abscissic Acid + Cartonenoid Derivative



The plant growth regulators (PGRs) are small, simple molecules of diverse chemical composition. They could be indole compounds (indole-3-acetic acid, IAA); adenine derivatives (N^6-furfurylamino purine, kinetin), derivatives of carotenoids (abscisic acid, ABA); terpenes (gibberellic acid, GA_3) or gases (ethylene, C_2H_4). Plant growth regulators are variously described as plant growth substances, plant hormones or phytohormones in literature.



Plant Growth Regulators

They are of two type (on the Basis of Function

PGP

Plant Growth promoters

(maximum Activities to Promote Growth

- Cell Division, Cell Elongation Flowering, Fruiting, tropic Growth

Ex - Auxin, Cytokinin, Gibberlin

PGI (Plant Growth Inhibiter)

- Roles to inhibit Growth
- Benefit - help to Survive in Difficult Condition

Ex - Abscissic Acid (Stress hormone)

note - Ethylene have Functions of PGP & PGI more PGI

The PGRs can be broadly divided into two groups based on their functions in a living plant body. One group of PGRs are involved in growth promoting activities, such as cell division, cell enlargement, pattern formation, tropic growth, flowering, fruiting and seed formation. These are also called plant growth promoters, e.g., auxins, gibberellins and cytokinins. The PGRs of the other group play an important role in plant responses to wounds and stresses of biotic and abiotic origin. They are also involved in various growth inhibiting activities such as dormancy and abscission. The PGR abscisic acid belongs to this group. The gaseous PGR, ethylene, could fit either of the groups, but it is largely an inhibitor of growth activities.

Auxin

- Discovery
- Bioassay
- Example
- Site of Synthesis
- Precursor

- Role & Application

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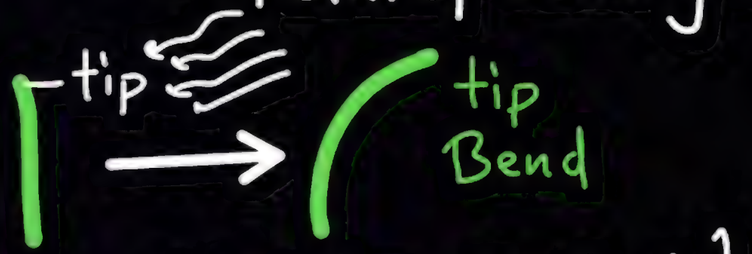
Auxin

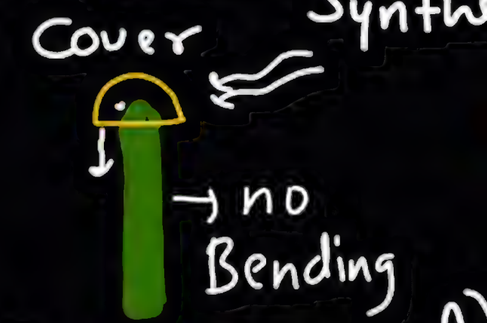
Discovery • Charles Darwin & Frasic Darwin → Study – Phototropism (Effect of light on shoot tip)

Study – Canary Grass

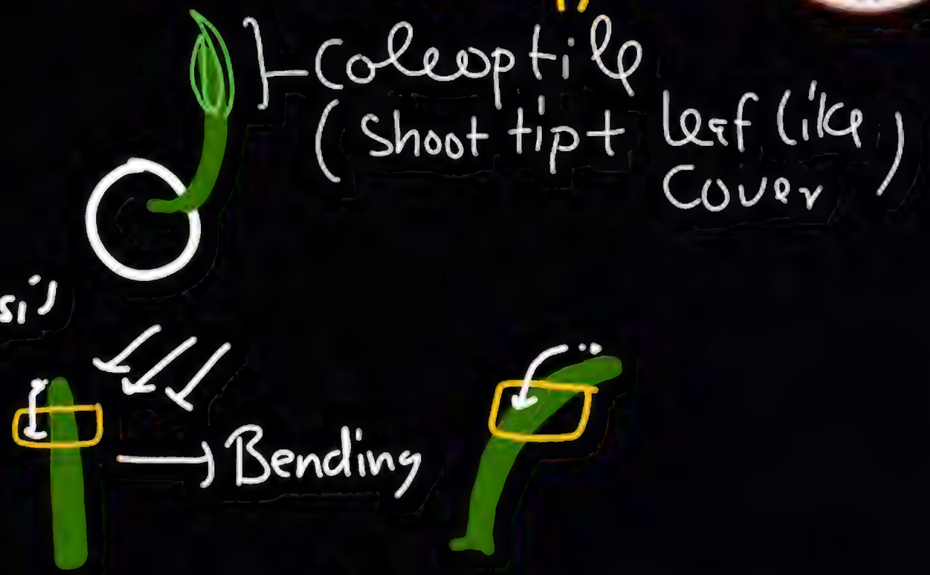
Observe → Unilateral illumination of light show
Bending — on coleoptile of canary Grass
– Point of Bending is Away From Sited



[Some chemical synthesis at tip & move Downward]



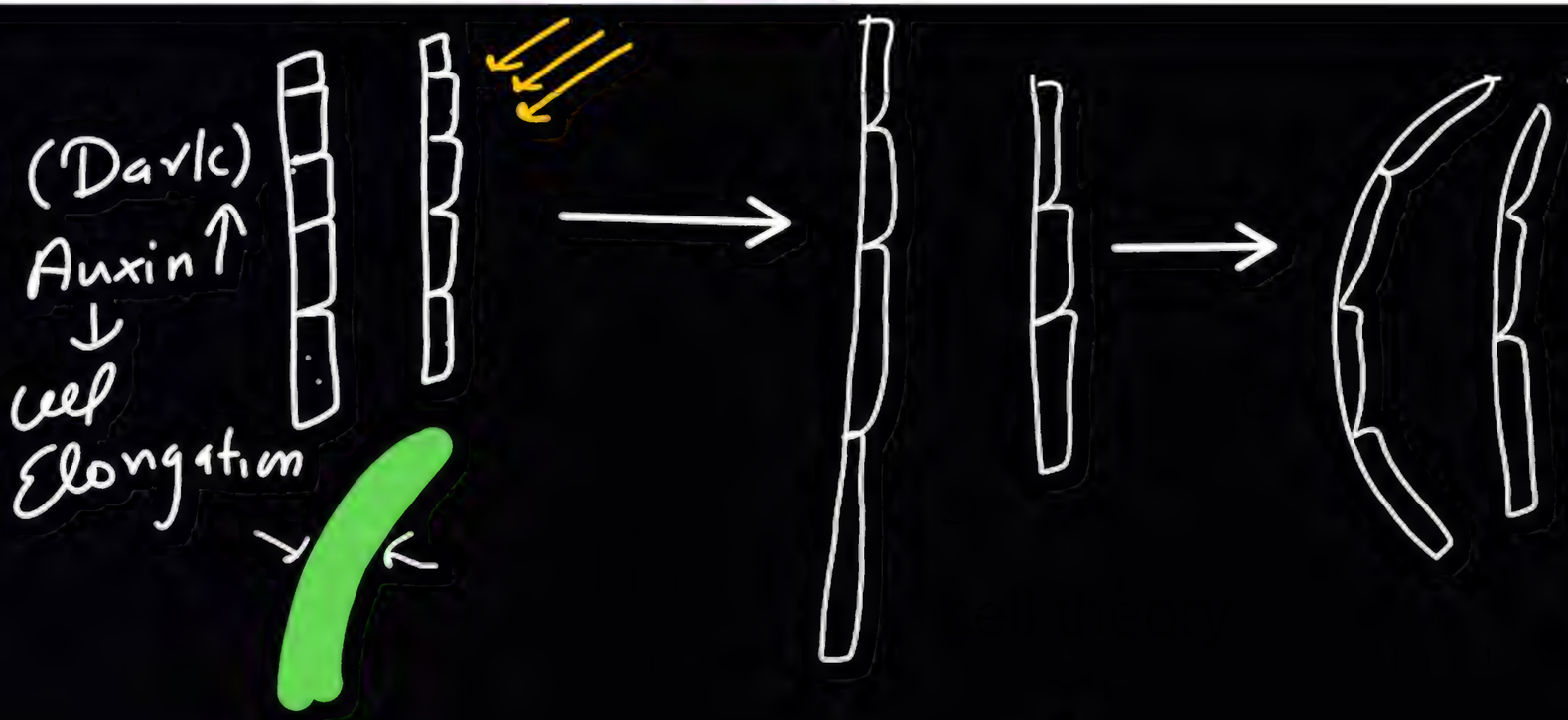
(no synthesis of chemical)

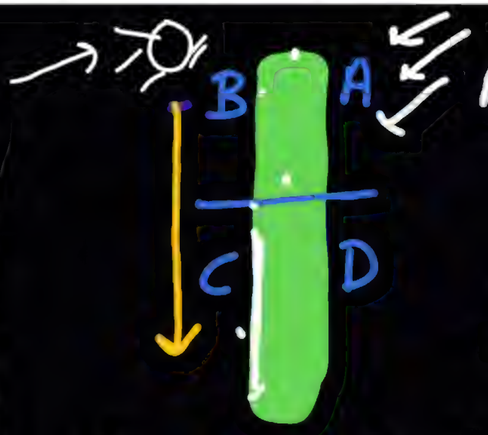


• F.W went → Isolate Auxin From Oat Coleoptile (Avena Sativa)

(note – Went not Able to Isolate Auxin in Free Form

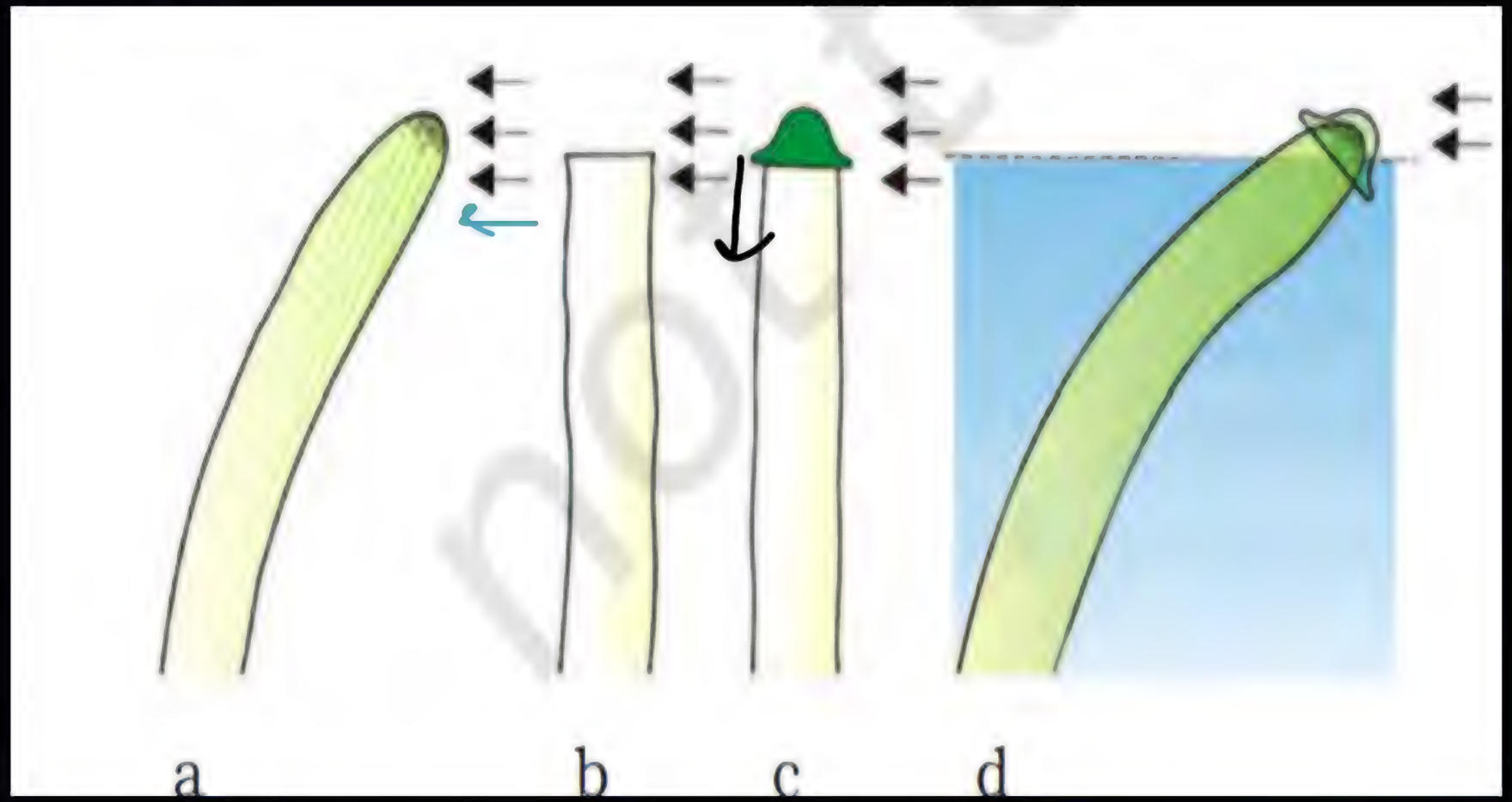
- Auxin - Discovery - Charles Darwin & Fransic Darwin — From Canary Grass
- Auxin Isolated → F.W went — From Oat coleoptile on Agar plate
- Auxin Isolated From Human Urine → By Kogl & Smith → Indole Acetic Acid (IAA)





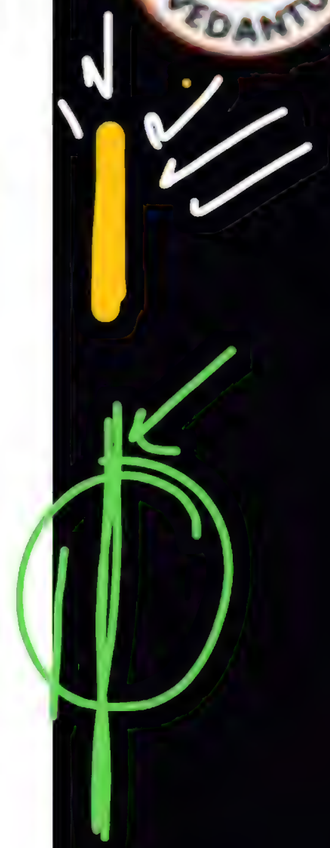
Auxin synthes
A
B
C
D

Auxin Activity Show
A B C D


a
b
c
d

Auxin

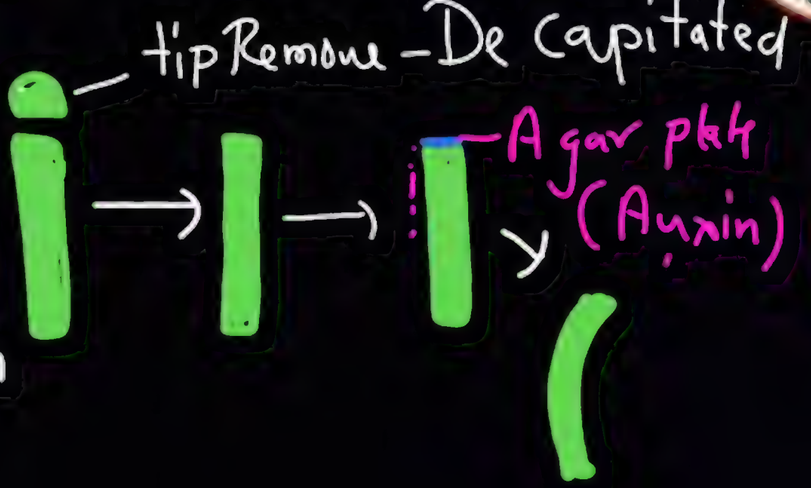
Interestingly, the discovery of each of the five major groups of PGRs have been accidental. All this started with the observation of Charles Darwin and his son Francis Darwin when they observed that the coleoptiles of canary grass responded to unilateral illumination by growing towards the light source (phototropism). After a series of experiments, it was concluded that the tip of coleoptile was the site of transmittable influence that caused the bending of the entire coleoptile (Figure 13.10). Auxin was isolated by F.W. Went from tips of coleoptiles of oat seedlings.

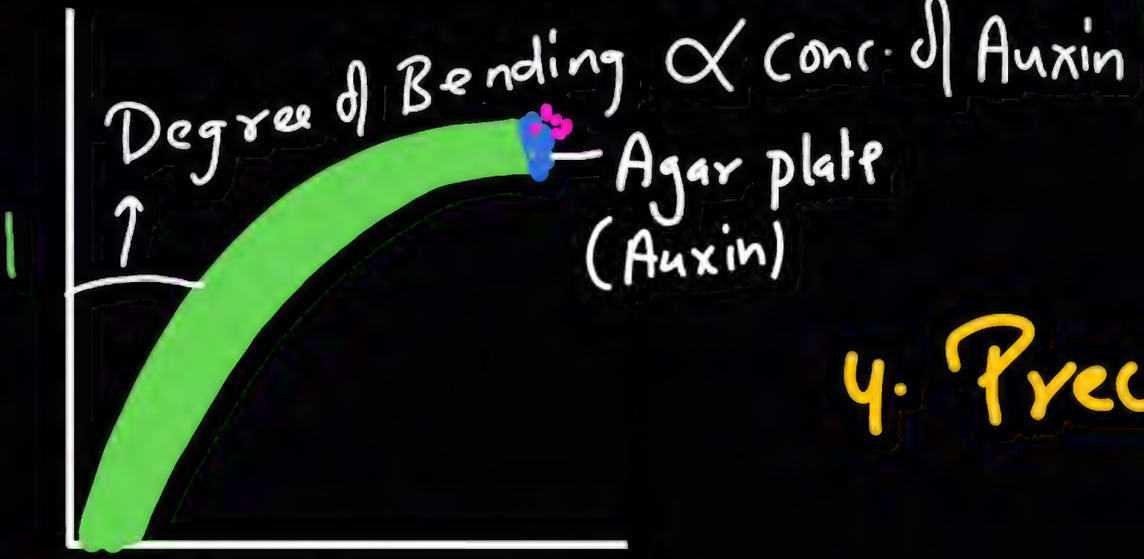


Auxin

1. Greek word → Auxien (to Grow)
   - Come From
   - Group of chemicals → Similar Function

2. Bioassay – Test to Find Role of Auxin
   - Bio – Test on Living
   - Assay – Test
   - (a) Avena coleoptile curvature test





3. Site of Synthesis – Shoot tip
   - Root tip

4. Precursor – Tryptophan Amino Acid (Indole Ring present)

Examples – Two type of Auxin

(a) Natural Auxin – Synthesis By Plant

IAA – Indole Acetic Acid

IBA → Indole Butyric Acid (Both Natural & Synthetic)

(b) Synthetic Auxin →

[2,4-D → 2,4 Dichloro phenoxy Acetic Acid
NAA – Napthalene Acetic Acid

Q S-I – all Auxin have indole ring ✗

S-II → 2,4-D is synthetic Auxin ✓

Auxins (from Greek 'auxein': to grow) was first isolated from human urine. The term 'auxin' is applied to the indole-3-acetic acid (IAA), and to other natural and synthetic compounds having certain growth regulating properties. They are generally produced by the growing apices of the stems and roots, from where they migrate to the regions of their action. Auxins like IAA and indole butyric acid (IBA) have been isolated from plants. NAA (naphthalene acetic acid) and 2, 4-D (2, 4-dichlorophenoxyacetic) are synthetic auxins. All these auxins have been used extensively in agricultural and horticultural practices.

Fluorine

Role of Auxin – total 7 Role

Auxin

1. Promote Rooting in stem cutting :-
Useful For Flower Industry (Adventitious Root)

2. Auxin → old leaf – Abscission & Drop promote (& Fruit)
Young leaf & Fruit – Abscission prevent
(Auxin promote old leaf & Fruit – Drop)

3. Auxin Promote Flowering in Pineapple

4. Auxin promote Apical Dominance
(Prevent Branching)
Use – tea plantation
– Hedge making

5. Auxin promote Parthenocarpy → Seed less Fruit Formation - Ex- Banana

6. Auxin Act as weedicide/herbicide Against Dicot
Ex- 2,4-D
Applicate - Kill Dicot weed in Grass lawn

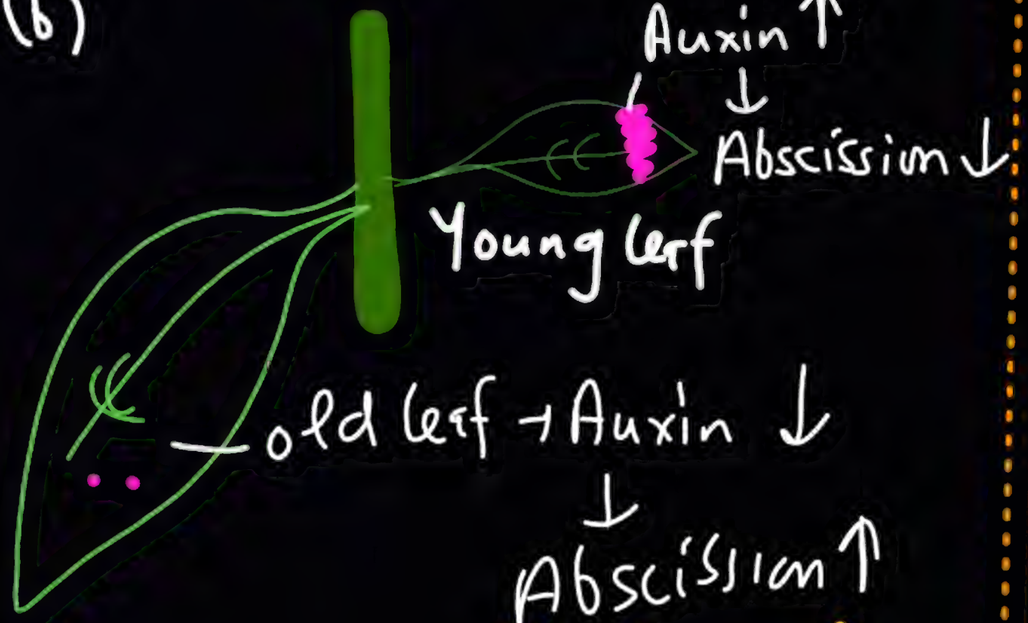
7. Cell Elongation & Xylem Differentiation

Appication

(a) Rooting in stem Cutting →

(Use in Flower industry (Horticulture)

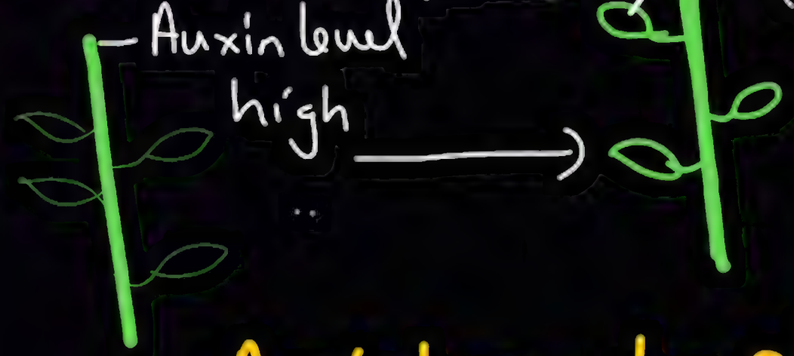
(b)



Abscission — Seperation/detachment

Senescence → Grow old

Apical Dominance

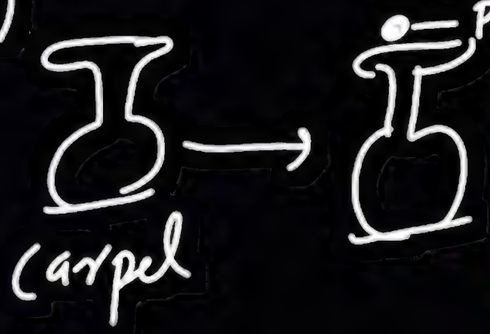


Auxin (Promote Growth of tip)
(Prevent Branching)
↓
Tip / Apex - Dominant → Means it Grow

Appication – tea plantation – tip cut – Auxin ↓ → Branch ↑

Parks → Hedge making → tip cut → Auxin ↓ → Branch ↑

(2)



→ (Ovary Auxin level Inc.) → Ovary convert into Fruit

(6)

Auxin spray – leaf Fall → kill Dicot plant

Grass lawn – Desirable – Grass
Unwanted – Dicot plant → weed

Auxin spray – 2,4-D (2,4 Di chloro phenoxy acetic Acid)

Agent orange – Auxin – high conc – Act as defoliator
∴ I Seperate Leaf

7.

Dividing cell
↓ Differentiate (By Auxin
Xylem

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Plant Growth and development

lecture - 04

Botany

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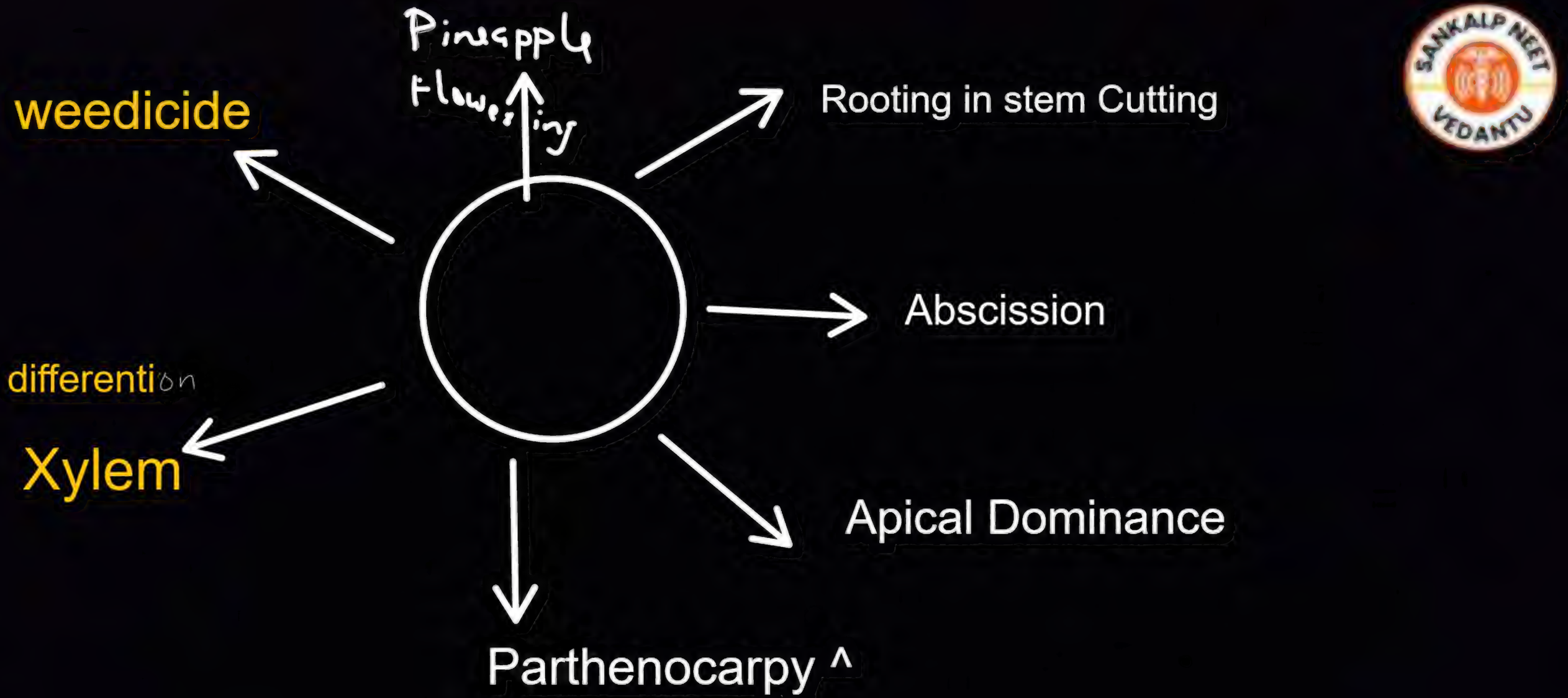
Today's Goal

Gibberlic Acid

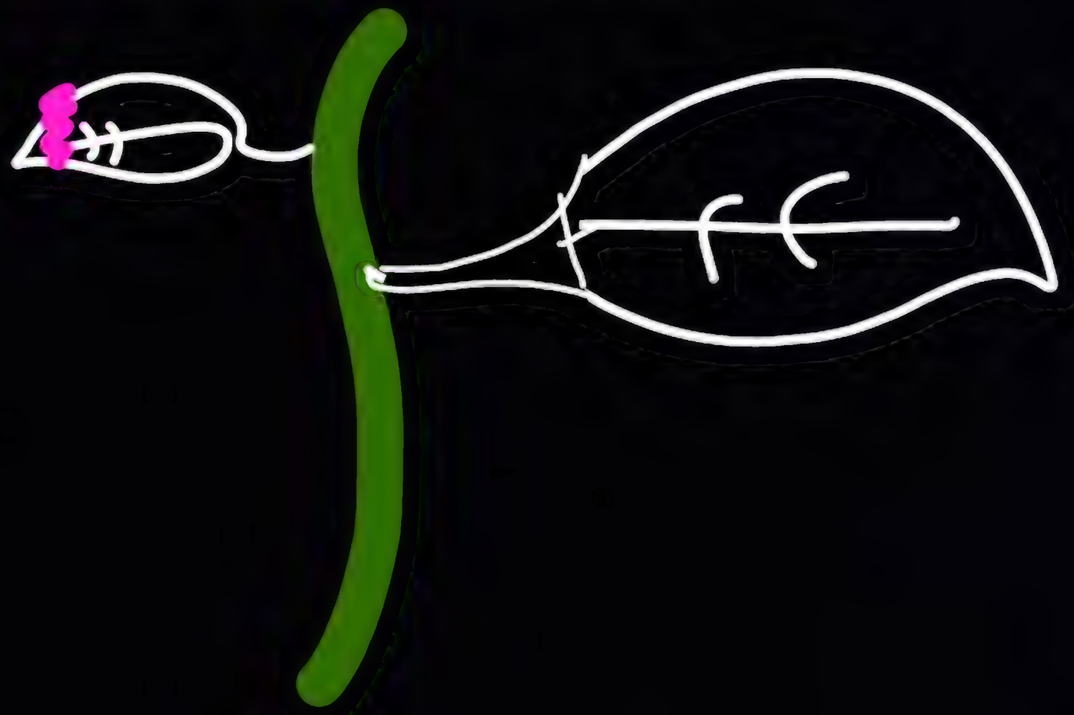
CytoKinin

Ethylene

ABA


Pineapple
Flowering
weedicide
Rooting in stem Cutting
Abscission
differentiation
Xylem
Apical Dominance
Parthenocarpy ^

They help to initiate rooting in stem cuttings, an application widely used for plant propagation. Auxins promote flowering e.g. in pineapples. They help to prevent fruit and leaf drop at early stages but promote the abscission of older mature leaves and fruits.



In most higher plants, the growing apical bud inhibits the growth of the lateral (axillary) buds, a phenomenon called **apical dominance**. Removal of shoot tips (decapitation) usually results in the growth of lateral buds (Figure 13.11). It is widely applied in tea plantations, hedge-making. Can you explain why?

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Auxins also induce parthenocarpy, e.g., in tomatoes. They are widely used as herbicides. 2, 4-D, widely used to kill dicotyledonous weeds, does not affect mature monocotyledonous plants. It is used to prepare weed-free lawns by gardeners. Auxin also controls xylem differentiation and helps in cell division.

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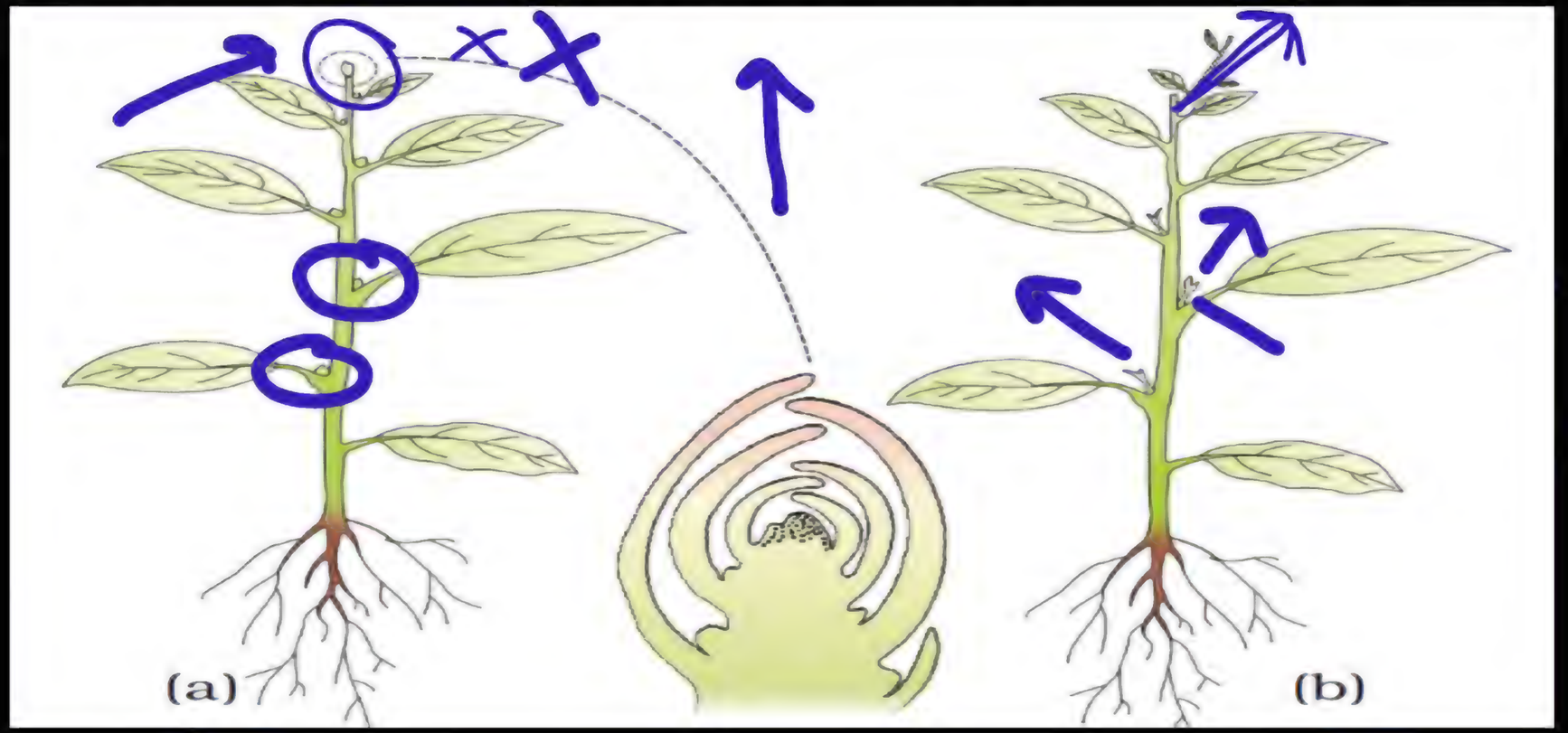
cell theory

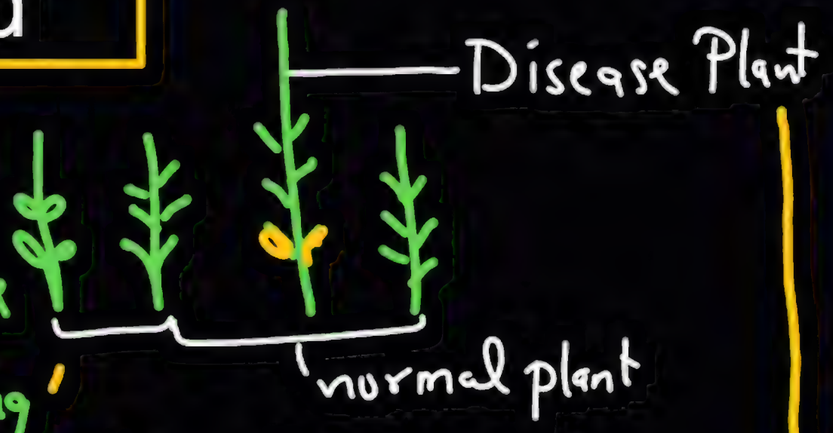

(a)
(b)

Gibberlic Acid

Discovery

E. kurosawa – studying disease in Rice plant – Bakane Disease

'Foolish seedling'



– Disease due to Fungus – 'Giberella fujikuroi'

Symptoms → length more

→ Yellow leaf, Sterile Plant

From Infected plant

Chemical Isolate (Sterile Filterate)

– Chemical use on normal plants

↓

Plant show inc. in length

(no Fungus only chemical)

later this chemical named as Gibberlic Acid

Gibbevlie Acid

The 'bakanae' (foolish seedling) disease of rice seedlings, was caused by a fungal pathogen *Gibberella fujikuroi*. E. Kurosawa (1926) reported the appearance of symptoms of the disease in rice seedlings when they were treated with sterile filtrates of the fungus. The active substances were later identified as gibberellic acid.

Gibberlic Acid

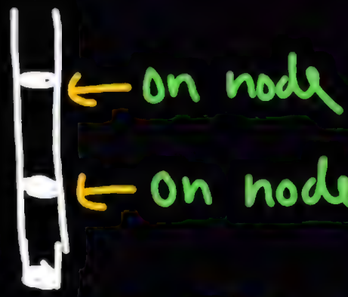
Precursor → terpene

site of synthesis → nodes, Seeds [Fungi synthesis of GA; Higher plants from GA]

Example → GA (Gibberlic Acid) → named as

GA_1 GA_2 GA_3 --- GA_{105} (More than 100 type of GA)

First Active GA → GA_3 (widely used)
(First Discovered GA)



Q GA not synthesis By
(a) Angiosperm
(b) Gymnosperm
(c) Some Fungus
(d) Algae

Bioassay

(or) Overcome of Genetic Dwarfism

(GA can inc. length of Dwarf Plant

Tall (TT, Tt)

Dwarf (tt) → GA Apply → Tall (tt)

tt
TT
Tt

Q Dwarf plant (tt) on which GA is applied it become tall

Now it is crossed with Dwarf → then progeny

(a) 100% tall (b) tall & Dwarf

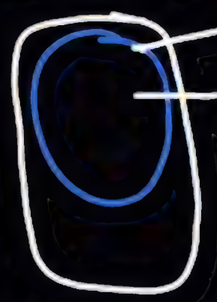
(c) ~~tt~~ all Dwarf (d) 25% Dwarf

GA → tall × (Dwarf) → all Dwarf

tt tt tt

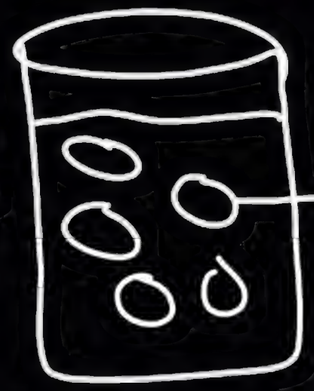
tt no change in Genotype

II Barley Endosperm Bioassay



Aleurone (Amylase Enzyme)

Endosperm (starch)



Barley seed (Soak in water)

Amylase Acting

Digest Starch

↓ Malting

Maltose (Glucose - Glucose)

↓

Glucose

GA Apply

Malting Fast

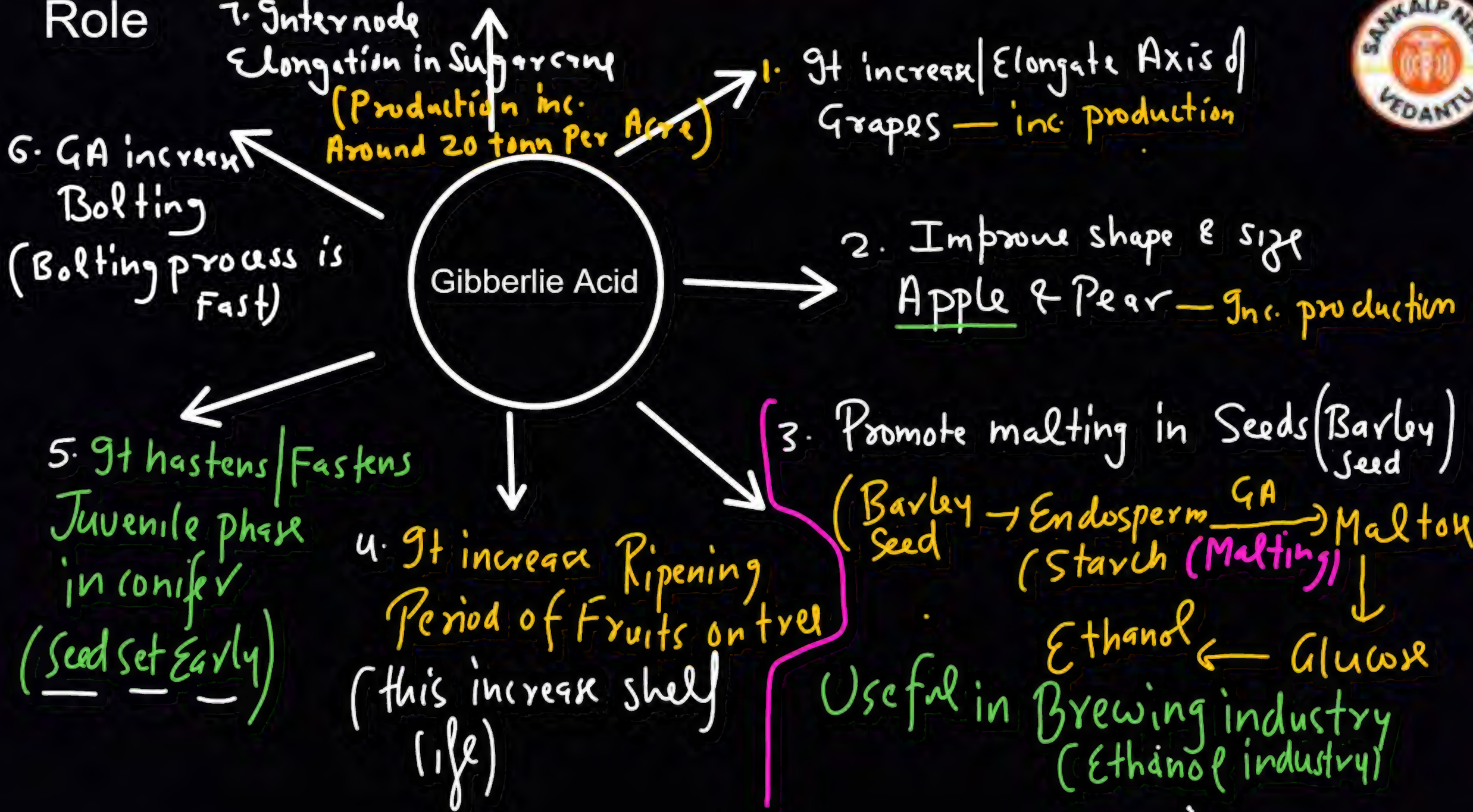
(Maltose & Glucose Fast)

- Due to GA → Melting occur → Reducing Sugar (like maltose Appear

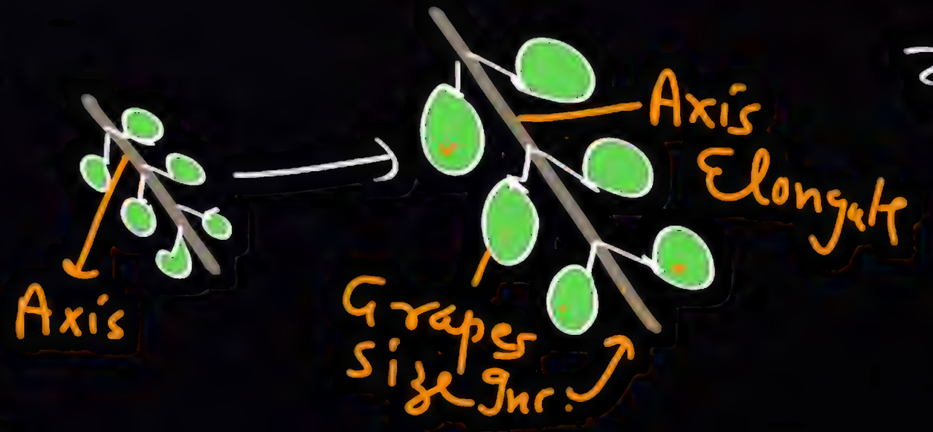
(Conversion of Starch into maltose)

Gibberellins are another kind of promotory PGR. There are more than 100 gibberellins reported from widely different organisms such as fungi and higher plants. They are denoted as GA_1, GA_2, GA_3 and so on. However, Gibberellic acid (GA_3) was one of the first gibberellins to be discovered and remains the most intensively studied form. All GAs are

Role


Gibberlie Acid
1. Gt increase/Elongate Axis of Grapes — inc. production
2. Improve shape & size Apple & Pear — Inc. production
3. Promote malting in Seeds (Barley seed)
(Barley Seed → Endosperm (Starch) —GA (Malting)→ Maltose → Glucose → Ethanol
Useful in Brewing industry (Ethanol industry)
4. Gt increase Ripening Period of Fruits on tree (this increase shelf life)
5. Gt hastens/Fastens Juvenile phase in conifer (Seed set Early)
6. GA increase Bolting (Bolting process is Fast)
7. Internode Elongation in Sugarcane (Production inc. Around 20 tonn Per Acre)

1.

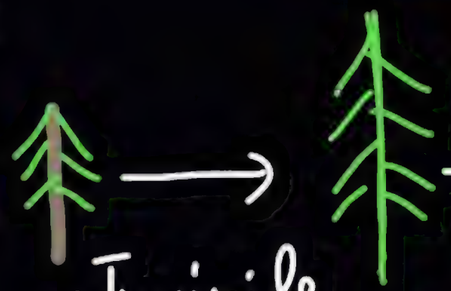


2.

Apple

Shape/size Improve

3.

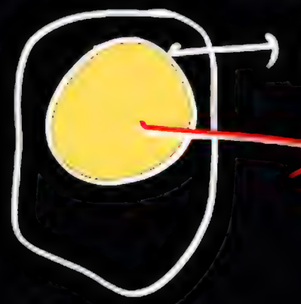


Juvinile or vegetative phase → Reproductive Phase

17-20 yr - Juvenile phase

(GA Apply - 5-6 yrs - Seed develop)

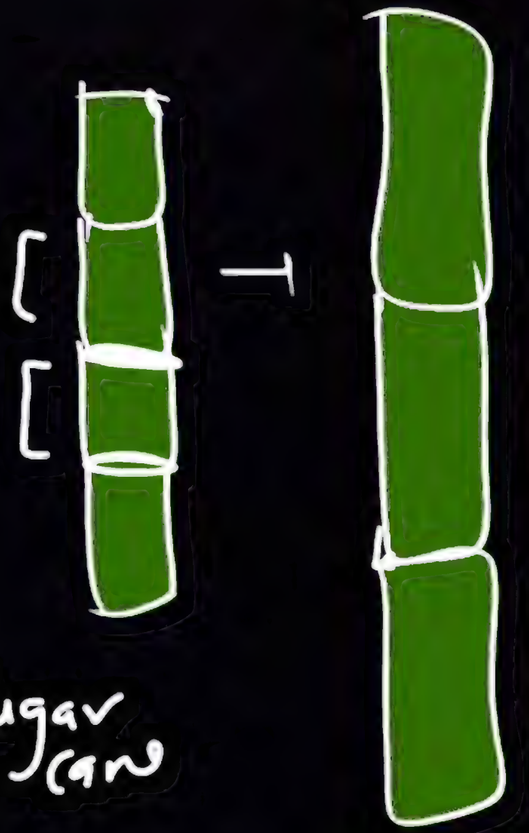
4. Brewing industry



Starch → Maltose

Malting (By GA)

S



Sugar cane

Internode Gnc. (Production Gnc.)

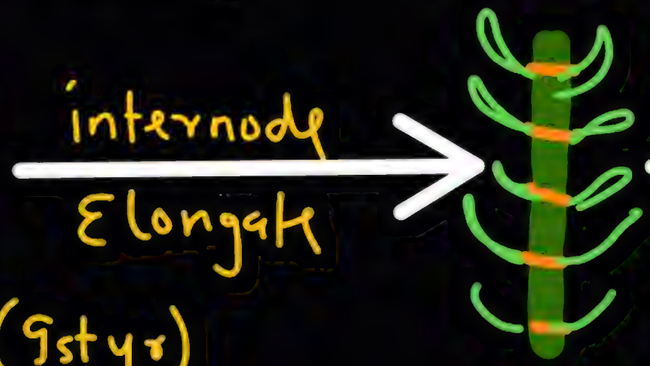
6. GA Gnc. Bolting

Cabbage (9st yr)

(Internode condense)

Leaf - close

(Rosette Habit)



Bolting → Plant with Rosette habit internode Elongation Followed By Flowering]

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acidic. They produce a wide range of physiological responses in the plants. Their ability to cause an increase in length of axis is used to increase the length of grapes stalks. Gibberellins, cause fruits like apple to elongate and improve its shape. They also delay senescence. Thus, the fruits can

length of grapes stalks. Gibberellins, cause fruits like apple to elongate and improve its shape. They also delay senescence. Thus, the fruits can be left on the tree longer so as to extend the market period. GA_3 is used to speed up the malting process in brewing industry.

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MANTHAN NEET 2025 1.0 & 2.0

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Plant Growth and development

lecture - 05

Botany

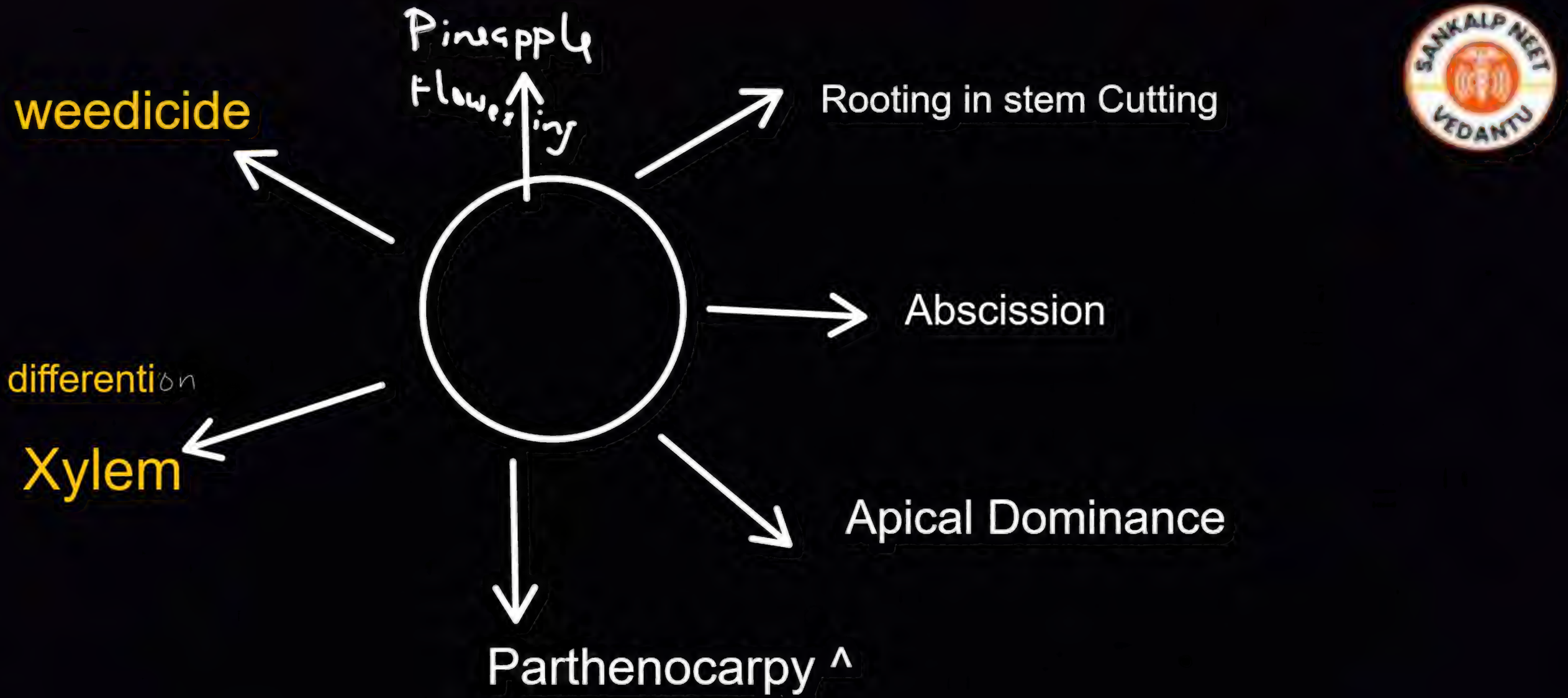
TARUN SIR

Today's Goal

Cytokinin

Ethylene

ABA


Pineapple
Flowering
weedicide
Rooting in stem Cutting
Abscission
differentiation
Xylem
Apical Dominance
Parthenocarpy ^

Role

Gibberlie Acid

1. Gt increase/Elongate Axis of Grapes — inc. production

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Apple & Pear — Inc. production

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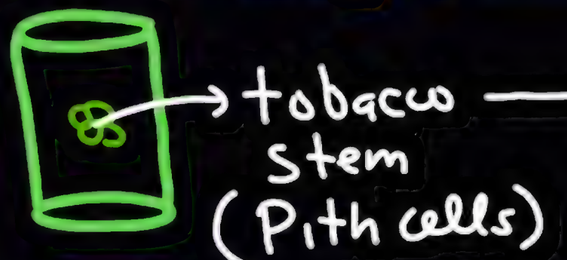
Cytokinin

Discovery – Skoog & Coworker – working on tissue culture



→ tobacco stem (Pith cells) →

Cells Culture start (Division promote) → Callus Formation / cell Division occur when → Auxin is supplimented with [Coconut Water / yeast Extract / Vascular cambium Extract]

Skoog & Miller – Isolate → Cytokinesis promoting chemical – **Kinetin**

From Herring Sperm DNA (Autoclave)

First cytokinin – Discovered – Kinetin (modified Purine) – Animal source

→ Plant source – First cytokinin → Zeatin (natural cytokinin) (Corn Kernel, Coconut water)

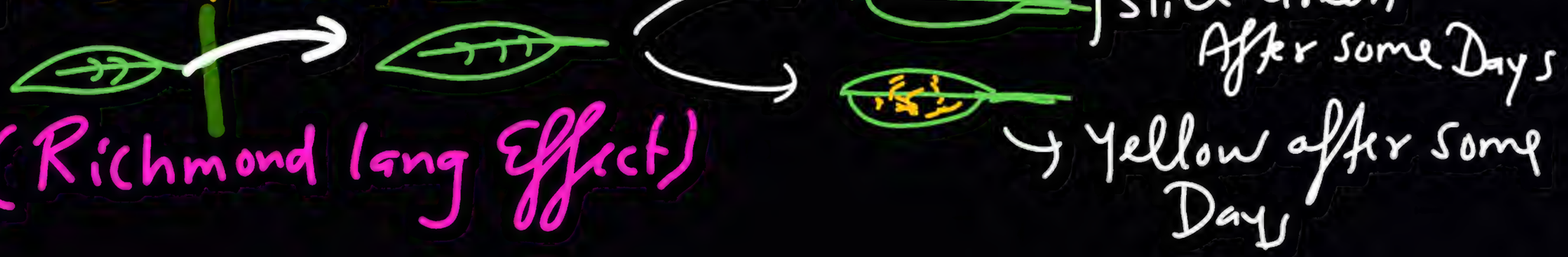
F. Skoog and his co-workers observed that from the internodal segments of tobacco stems the callus (a mass of undifferentiated cells) proliferated only if, in addition to auxins the nutrients medium was supplemented with one of the following: extracts of vascular tissues, yeast extract, coconut milk or DNA. Miller et al. (1955), later identified and crystallised the cytokinesis promoting active substance that they termed kinetin.

Example — Kinetin (Animal source), Zeatin (Plant source)

Precursor → DNA → Purine (Adenine) → Cytokinin

site of synthesis — Fast cell Divisim — (1) Root tip (2) Fruits (3) Young leaf (4) Buds

Bioassay → Delay in leaf senescence

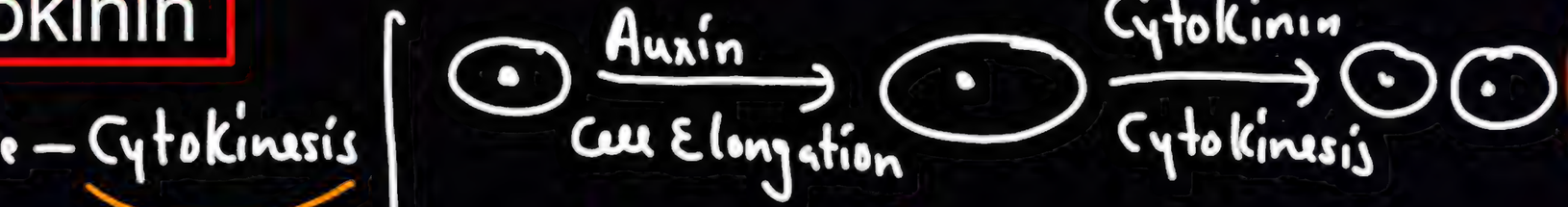


Cytokinins have specific effects on cytokinesis, and were discovered as kinetin (a modified form of adenine, a purine) from the autoclaved herring sperm DNA. Kinetin does not occur naturally in plants. Search for natural substances with cytokinin-like activities led to the isolation of zeatin from corn-kernels and coconut milk. Since the discovery of zeatin, several

corn-kernels and coconut milk. Since the discovery of zeatin, several naturally occurring cytokinins, and some synthetic compounds with cell division promoting activity, have been identified. Natural cytokinins are

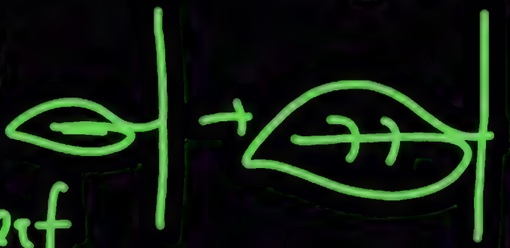
Role of cytokinin

(a) Cytokinin promote – Cytokinesis



(b) Division promote in Young leaf

(Promote Formation of Young leaf



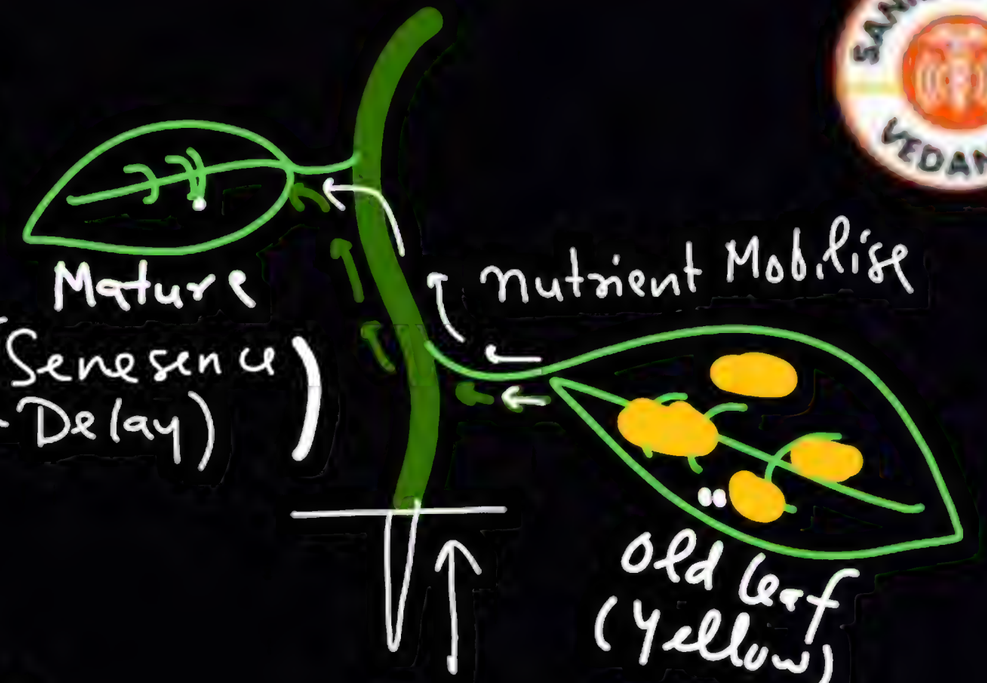
(c) Cytokinin promote Division of chloroplast (new chloroplast)

(d) Promote lateral Branched (From Axillary Bud) — work opposite Auxin (Antagonist)

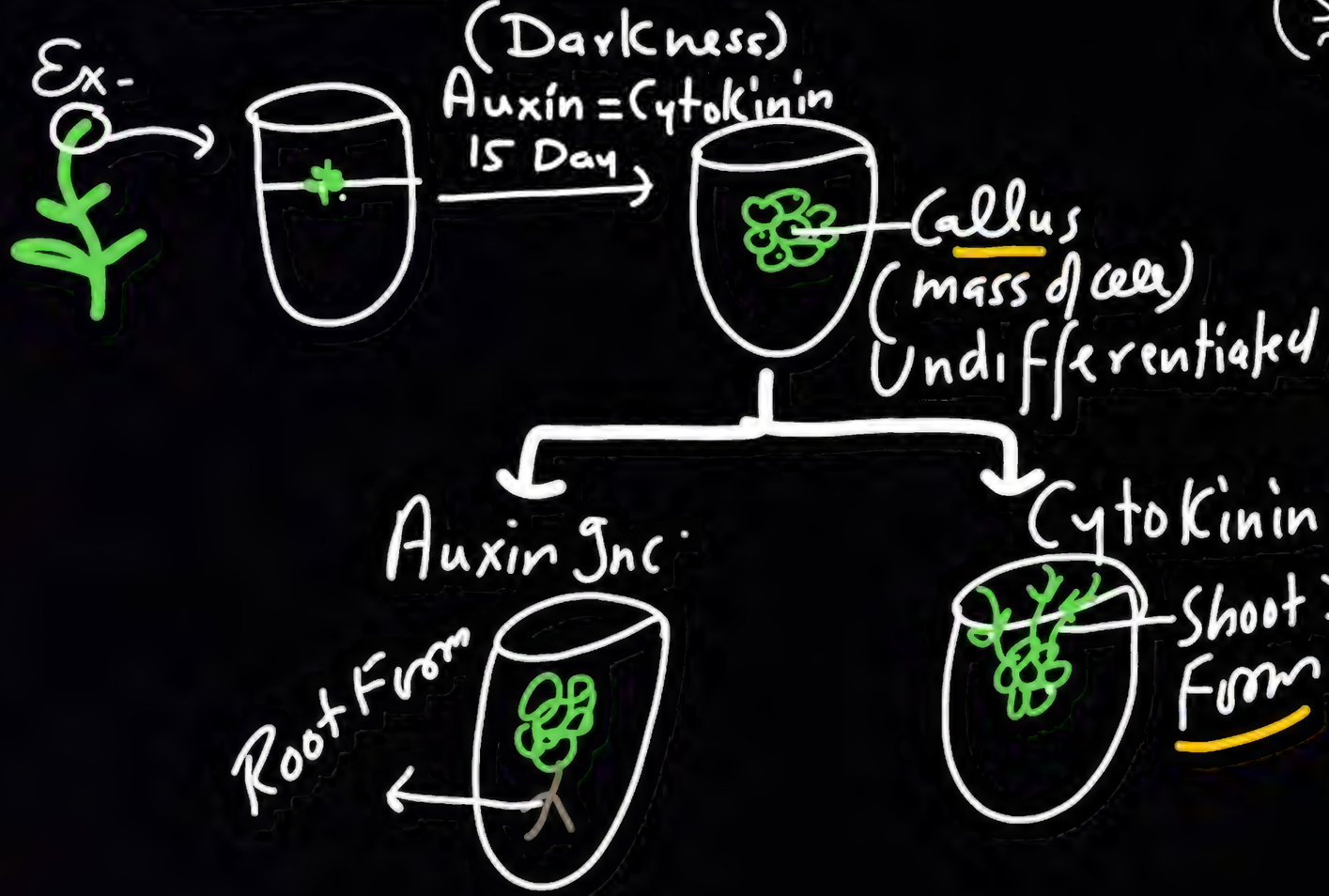
Auxin – Stop / Prevent – lateral Branches

Cytokinin → Promote – lateral Branch

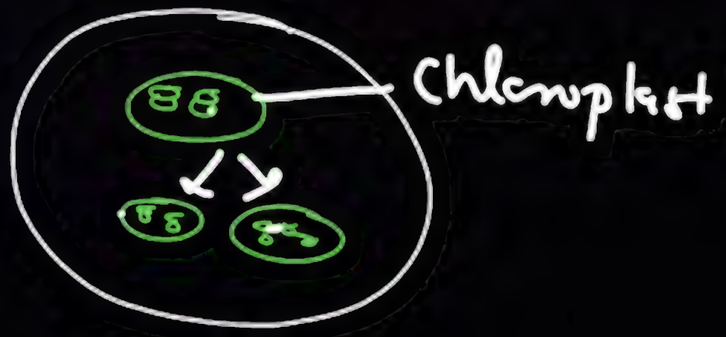
(e) nutrient Mobilization ⟶ Leaf Senescence delay

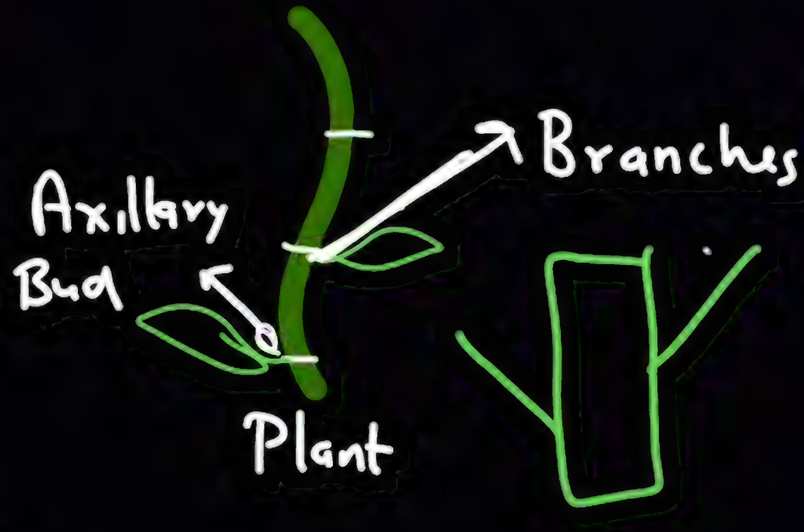


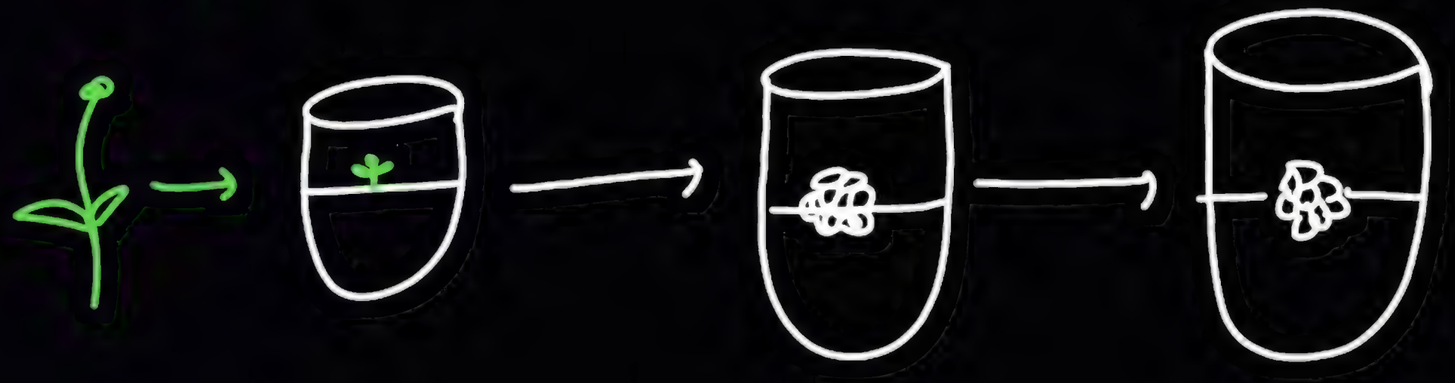
(f) Adventitious Bud Formation



Explanation







synthesised in regions where rapid cell division occurs for example, root apices, developing shoot buds, young fruits etc. It helps to produce new leaves chloroplasts in leaves, lateral shoot growth and adventitious shoot formation. Cytokinins help overcome the apical dominance. They promote nutrient mobilisation which helps in the delay of leaf senescence.

Ethylene

Discovery – Cousins → Ripened orange → Produce some gas / Volatile compound

Promote Ripening in Stored Unripened Banana

site of synthesis → old leaf / Ripened Fruit / old Flower

(all plant part undergoing Senesence)

Example – Ethylene (Gas), Ethephone (Aqueous Form)

Precursor → Methionine (Amino Acid) ⟶ Ethylene gas

H.H Cousins (1910) confirmed the release of a volatile substance from ripened oranges that hastened the ripening of stored unripened bananas. Later this volatile substance was identified as ethylene, a gaseous PGR.

Let us study some of the physiological effects of these five categories of PGRs in the next section.

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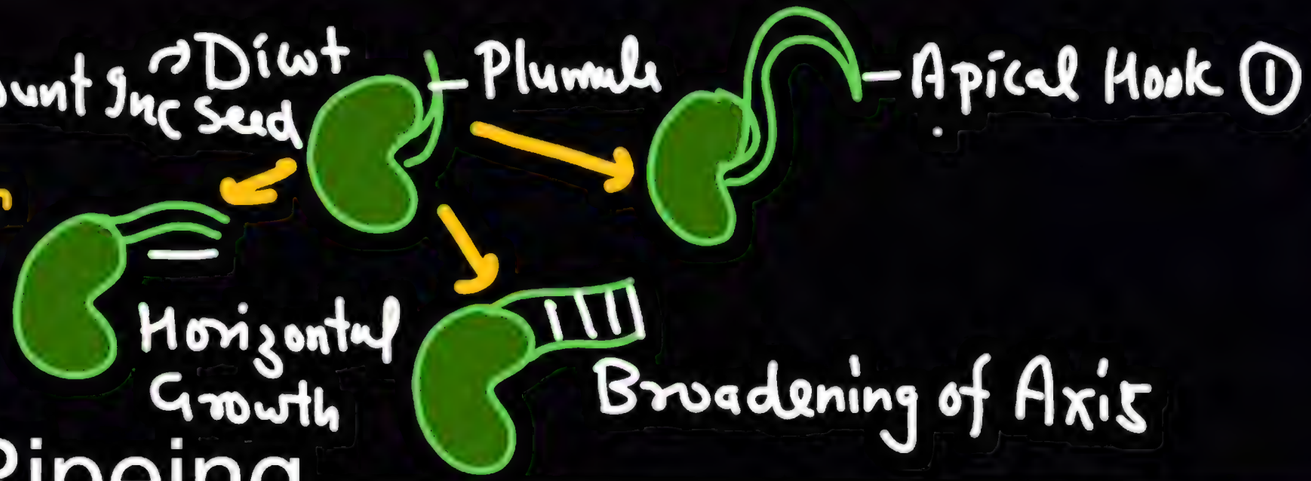
Bioassay → Ethylene Amount ↑ in Dicot seed

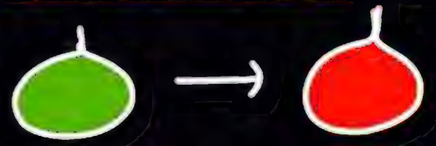
on Dicot seed - During germination Triple Response observed



Fruit Ripeing

I Climacteric

Ex- Mango, Banana → Changes



(a) Colour Change

(b) Acid convert sugar

(c) Middle lamella Dissolve

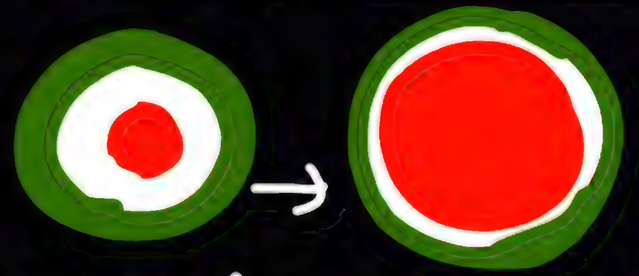
(d) Respiration Rate ↑nc.

(Respiratory Climacteric)

Non climacteric

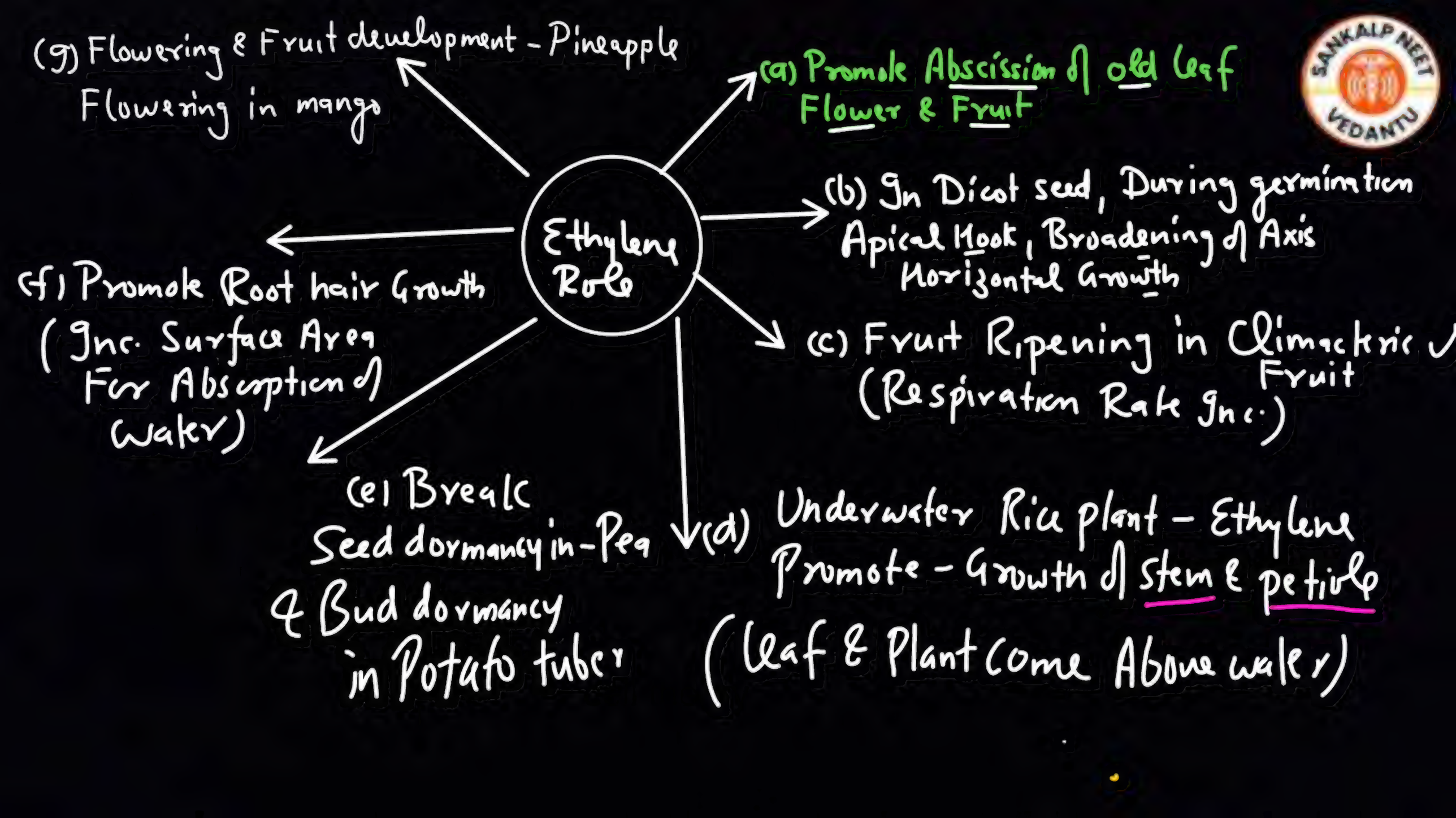
Ripening

(No ↑nc. in Respiration Rate)

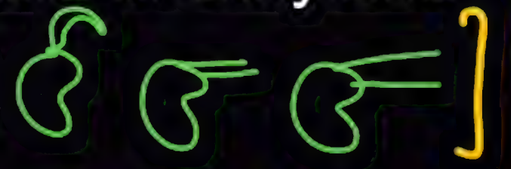


Watermelon (UnRipened)

Ripened (Fruit wall thin


(g) Flowering & Fruit development - Pineapple
Flowering in mango
(a) Promote Abscission of old leaf
Flower & Fruit
Ethylene Role
(b) In Dicot seed, During germination
Apical Hook, Broadening of Axis
Horizontal Growth
(f) Promote Root hair Growth
(Inc. Surface Area
For Absorption of
Water)
(c) Fruit Ripening in Climacteric
Fruit
(Respiration Rate Inc.)
(e) Break
Seed dormancy in-Pea
& Bud dormancy
in Potato tuber
(d) Underwater Rice plant - Ethylene
Promote - Growth of Stem & petiole
(Leaf & Plant come Above water)

Role of Ethylene

① 

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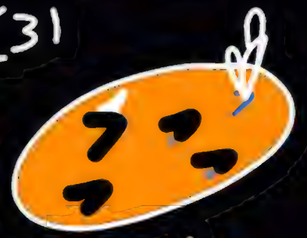
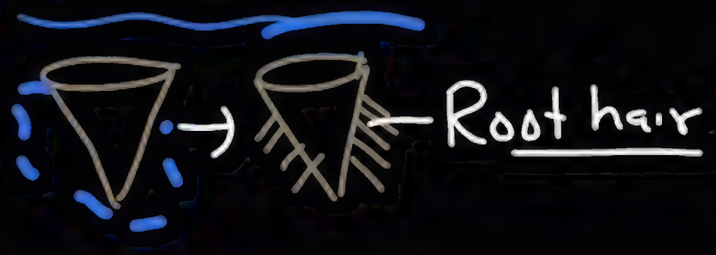
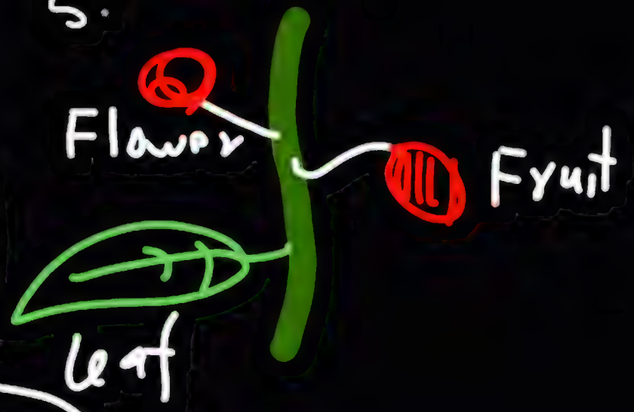
(3) 

4. 

5. 

Ethylene is a simple gaseous PGR. It is synthesised in large amounts by tissues undergoing senescence and ripening fruits. Influences of ethylene on plants include horizontal growth of seedlings, swelling of the axis and apical hook formation in dicot seedlings. Ethylene promotes senescence and abscission of plant organs especially of leaves and flowers. Ethylene is highly effective in fruit ripening. It enhances the respiration rate during ripening of the fruits. This rise in rate of respiration is called respiratory climactic.

Ethylene breaks seed and bud dormancy, initiates germination in peanut seeds, sprouting of potato tubers. Ethylene promotes rapid internode/petiole elongation in deep water rice plants. It helps leaves/ upper parts of the shoot to remain above water. Ethylene also promotes root growth and root hair formation, thus helping the plants to increase their absorption surface.

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Ethephon

- Aqueous Form of Ethylene
- Readily Absorb - Absorb Fast
- Slowly Diffuse in Tissue

Three Function — Ethephon

(a) Promote Flowering in Apple & tomato

(b) Promote Female Flower in Cucumber (Production Inc.)

(c) Promote thinning of Fruit wall → (cherry, Cotton, walnut

their absorption surface.

Ethylene is used to initiate flowering and for synchronising fruit-set in pineapples. It also induces flowering in mango. Since ethylene regulates so many physiological processes, it is one of the most widely used PGR in agriculture. The most widely used compound as source of ethylene is ethephon. Ethephon in an aqueous solution is readily absorbed and transported within the plant and releases ethylene slowly. Ethephon hastens fruit ripening in tomatoes and apples and accelerates abscission in flowers and fruits (thinning of cotton, cherry, walnut). It promotes female flowers in cucumbers thereby increasing the yield.

Abscisic Acid

Discovery - 1960s — three Chemical Discovered at Different place

Dormin
Inhibitor B
Abscission II
(Growth inhibit)
} — They are chemically same — Abscissic Acid

Precursor → Carotenoids

Site of Synthesis — old leaf, chloroplast (Guard cell), seed

Example — Abscission II, Dormin, Inhibitor B

During mid-1960s, three independent researches reported the purification and chemical characterisation of three different kinds of inhibitors: inhibitor-B, abscission II and dormin. Later all the three were proved to be chemically identical. It was named abscisic acid (ABA).

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Role of Abscisic

(a) Seed – Promote Seed dormancy
(ABA Antagonist to GA)

GA – promote seed germination like Barley
ABA – promote seed dormancy

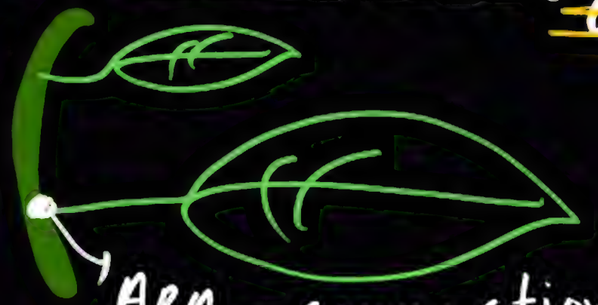
→ Role – Seed germination

(b) ABA – control – Seed dormancy, Seed maturation & Seed development

(c) Water stress → guard cell → ABA promote – stomata close (Afternoon)
(Stress Hormone)

(d) old leaf → Promote Abscission →

(e) It is General Plant Growth Inhibitor



ABA – connection weak

13.4.3.5 Abscisic acid

As mentioned earlier, abscisic acid **(ABA)** was discovered for its role in regulating abscission and dormancy. But like other PGRs it also has other wide ranging effects on plant growth and development. It acts as a general plant growth inhibitor and an inhibitor of plant metabolism. ABA inhibits seed germination. ABA stimulates the closure of stomata and increases the tolerance of plants to various kinds of stresses. Therefore, it is also called the stress hormone. ABA plays an important

Antagonist and Synergistic Hormone

Role - opposite - Antagonist

Role - together - Synergistic

Hormone pair	Role	Synergistic	Antagonist
(a) Auxin - Cytokinin	- Apical Dominance	×	✓
	- Callus →	✓	×
(b) Auxin - Ethylene	- Flowering in Pineapple	✓	×
	- Abscission	✓	×
(c) GA - ABA	— Seed dormancy →	×	✓

Note - For particular Role Hormones can be Synergistic or Antagonist

cell theory

cell theory

MANTHAN NEET 2025

Anatomy of flowering plants

lecture number- 01

Botany

TARUN SIR

Anatomy of Flowering plants

Topic

1. Meristimatic
2. Simple permanent tissue
3. Complex permanent tissue

4. Tissue System
5. Section of leaf, stem & Root
6. Secondary Growth X

New NCERT — 4, 5

Complete understanding (1, 2, 3, 4, 5)

Today's Goal

Meristematic tissue

Simple permanent tissue

Anatomy – Study of internal structure – Root, stem, leaf

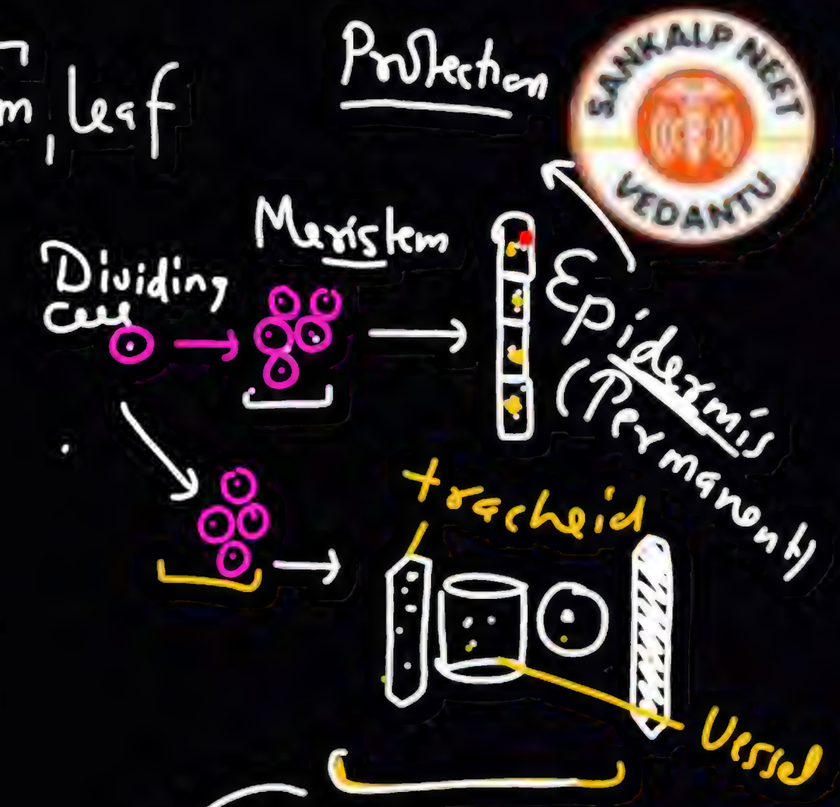
Change with Environment → Show Adaptation

Tissue – Group of cells with Common origin & Similar Function

Q

✓ S-1 – Tissue common origin & common Function

✗ S-1 Tissue cells similar structure



(transport of water) (Structure Different)

You can very easily see the structural similarities and variations in the external morphology of the larger living organism, both plants and animals. Similarly, if we were to study the internal structure, one also finds several similarities as well as differences. This chapter introduces you to the internal structure and functional organisation of higher plants. Study of internal structure of plants is called anatomy. Plants have cells as the basic unit, cells are organised into tissues and in turn the tissues are organised into organs. Different organs in a plant show differences in their internal structure. Within angiosperms, the monocots and dicots are also seen to be anatomically different. Internal structures also show adaptations to diverse environments.

6.1 The Tissues

A tissue is a group of cells having a common origin and usually performing a common function. A plant is made up of different kinds of tissues. Tissues are classified into two main groups, namely, meristematic and permanent tissues based on whether the cells being formed are capable of dividing or not.

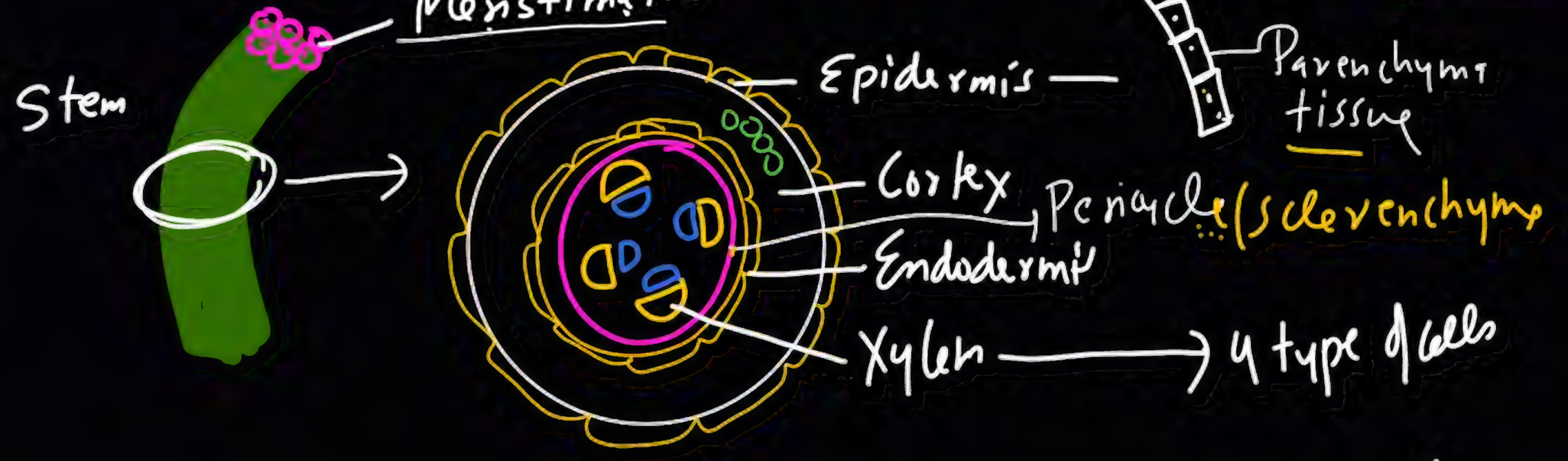
Tissue

Meristematic tissue
- Dividing cells Group

Permanent
- Role Fix | Size Fix - Differentiate

Simple permanent tissue (All cells are of one type)
- Parenchyma
- Collenchyma
- Sclerenchyma

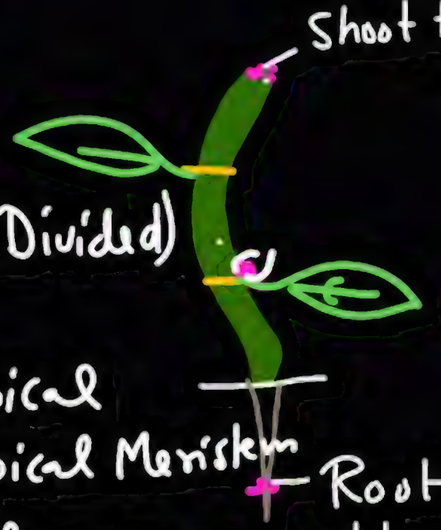
Complex Permanent (more than one type of cells)
- Xylem →
- phloem →



Meristimatic tissue

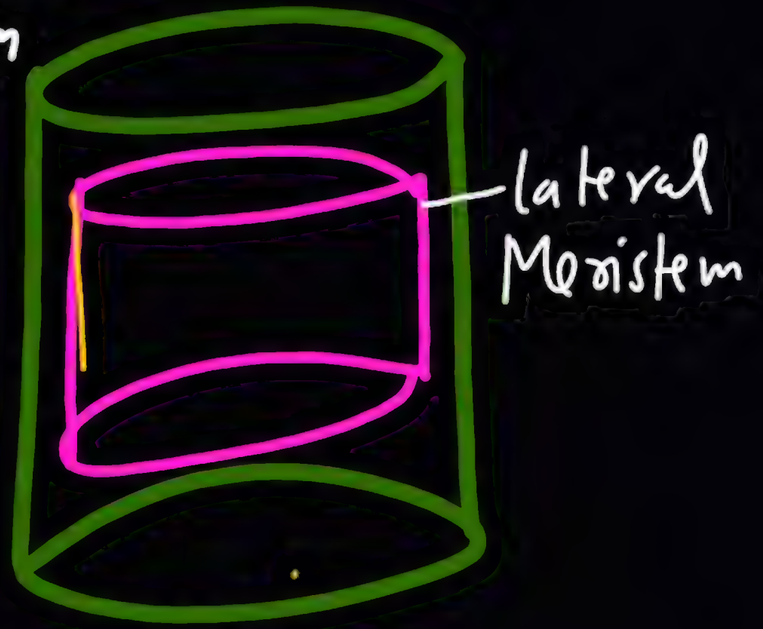
meristem – Group of Dividing cell (Derive From Meristos – to be Divided)

Ex–
- Shoot Apical
- Root Apical Meristem
- Intercalary Meristem
- lateral Meristem



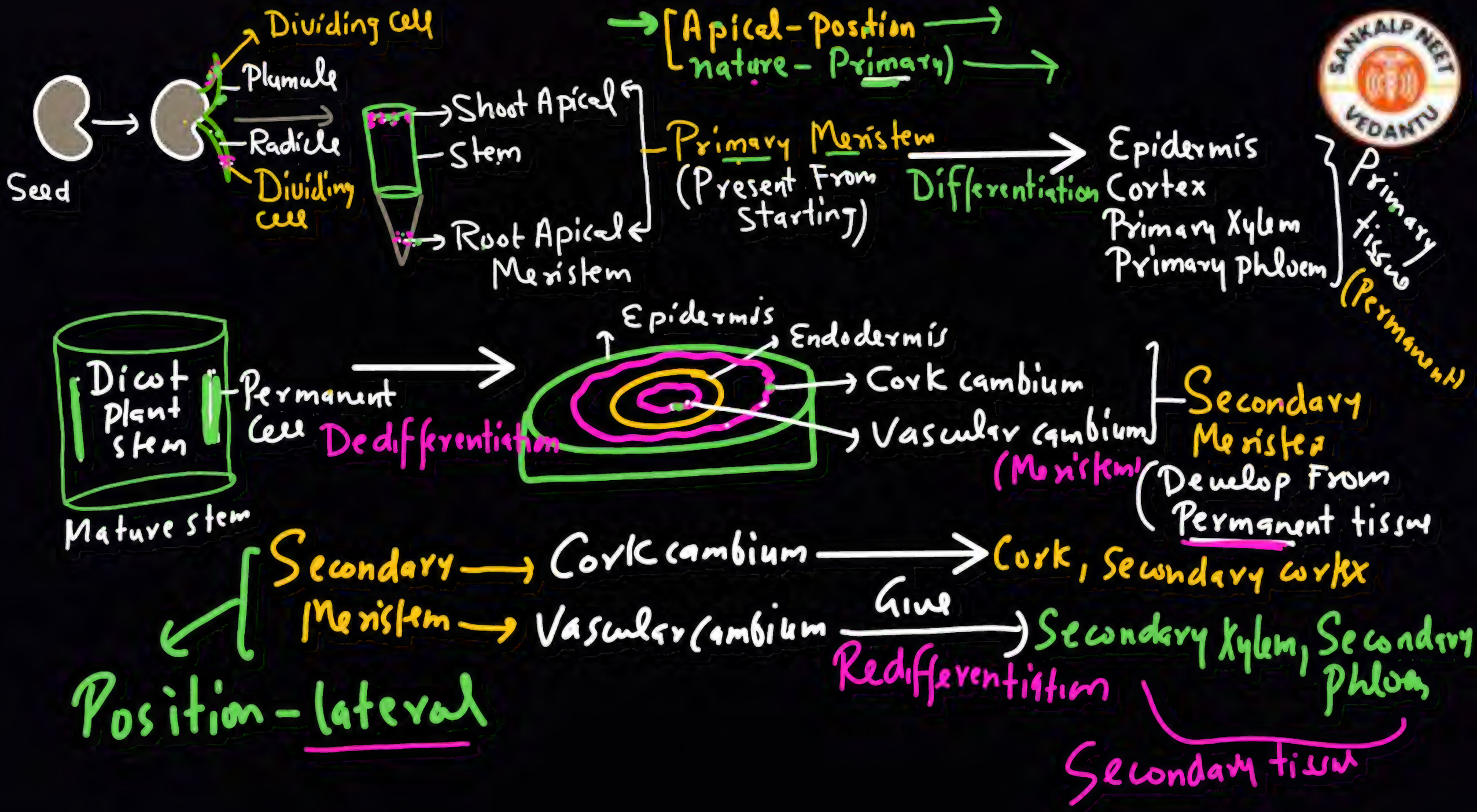
feature of Meristimatil cell

(a) Small size
(b) large nucleus | conspicuous nucleus
(c) Cell wall – primary thin
(d) Vacuole Absent
(e) Multiple plasmodesmatal connection
(f) No intercellular space
(g) Dense protoplasm



6.1.1 Meristematic Tissues

Growth in plants is largely restricted to specialised regions of active cell division called **meristems** (*Gk. meristos*: divided). Plants have different kinds of meristems. The meristems which occur at the tips of roots and shoots and produce primary tissues are called **apical meristems** (Figure 6.1).


Dividing cell
Plumule
Radicle
Dividing cell
Seed
Shoot Apical
Stem
Root Apical
Meristem
→ [Apical - Position
nature - Primary] →
Primary Meristem
(Present From Starting)
Differentiation
Epidermis
Cortex
Primary Xylem
Primary Phloem
Primary tissue
(Permanent)
SANKALP NEET VEDANTU
Dicot plant stem
Permanent cell
Dedifferentiation
Epidermis
Endodermis
Cork cambium
Vascular cambium
(Meristem)
Secondary Meristem
(Develop From Permanent tissue)
Mature stem
Secondary Meristem
Cork cambium → Cork, Secondary cortex
Vascular cambium → Give → Secondary Xylem, Secondary Phloem
Rediffrentiation
Secondary tissue
Position - lateral

Shoot Apical Meristem
Root Apical Meristem
(Primary)

→ Process - Differentiation → Primary tissue - Epidermis
Endodermis
Primary Xylem, Primary Phloem
Pith

Permanent cells
(Dicot stem, Dicot Root)

→ De Differentiation → Again Dividing cells - Secondary Meristem (nature)

Ex - Cork cambium
Vascular cambium

Position - lateral

Secondary Meristem
Cork cambium
Vascular cambium

→ Re differentiation → Secondary tissue
Cork, Secondary cortex
Secondary Xylem, Secondary Phloem

Classification of meristem

On the Basis of location

(a) Apical Meristem ✓

(b) Intercalary ✓

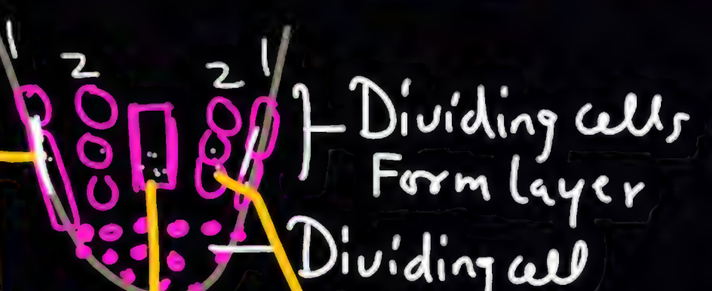
(c) lateral ✓

On the Basis of origin

(a) Primary
- Present From starting
- Give Primary tissue

(b) Secondary Meristem
→ develop From permanent tissue
→ Give Secondary tissue
(S.X, S.P, Cork, Secondary cortex)

On the Basis of Fate / Future



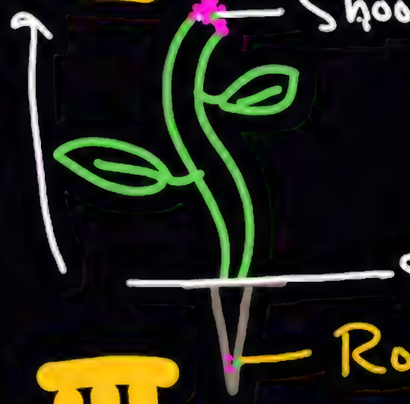
(a) Protoderm
↓
Give Epidermis

(c) Ground Meristem
- Cortex
- Pith

(b) Procambium
Give vascular Bundle (Xylem Phloem)

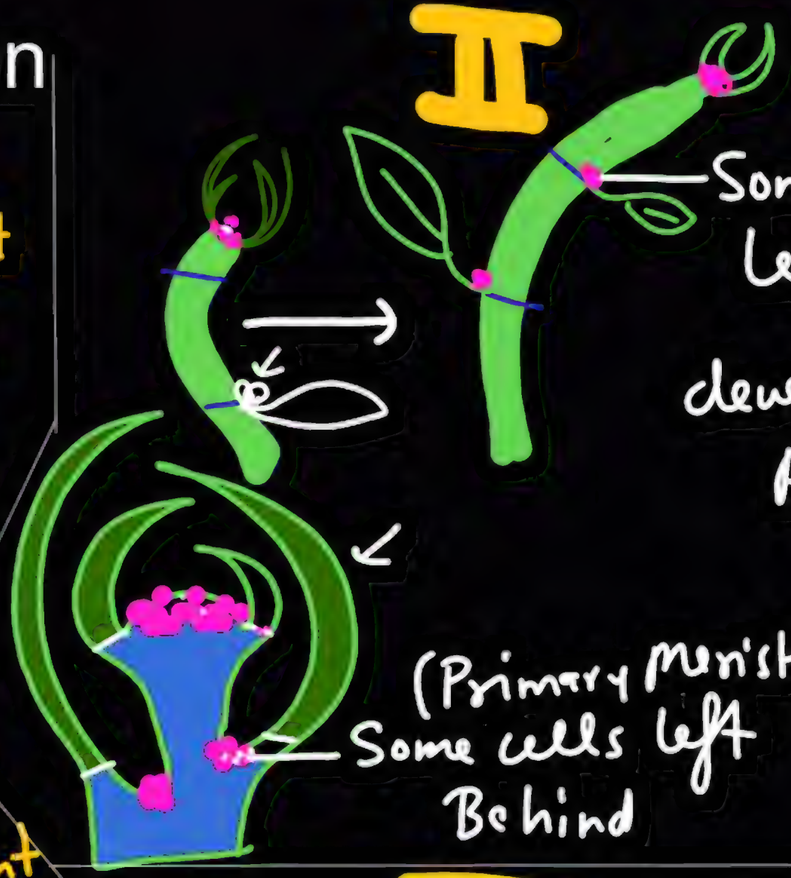
on the Basis of location

I



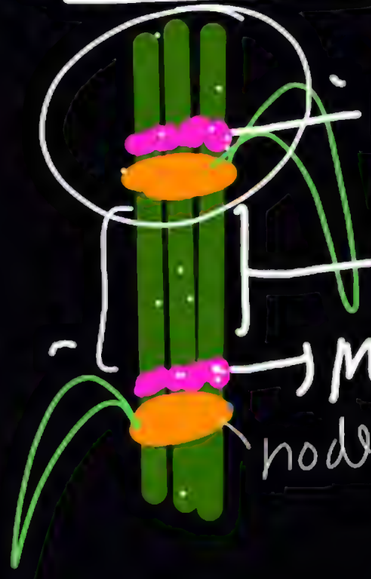
- Shoot Apical – Growth in length
  - New leaf Form
  - Distant most part of shoot
  - Primary-nature
- Root Apical – Growth of Root

II



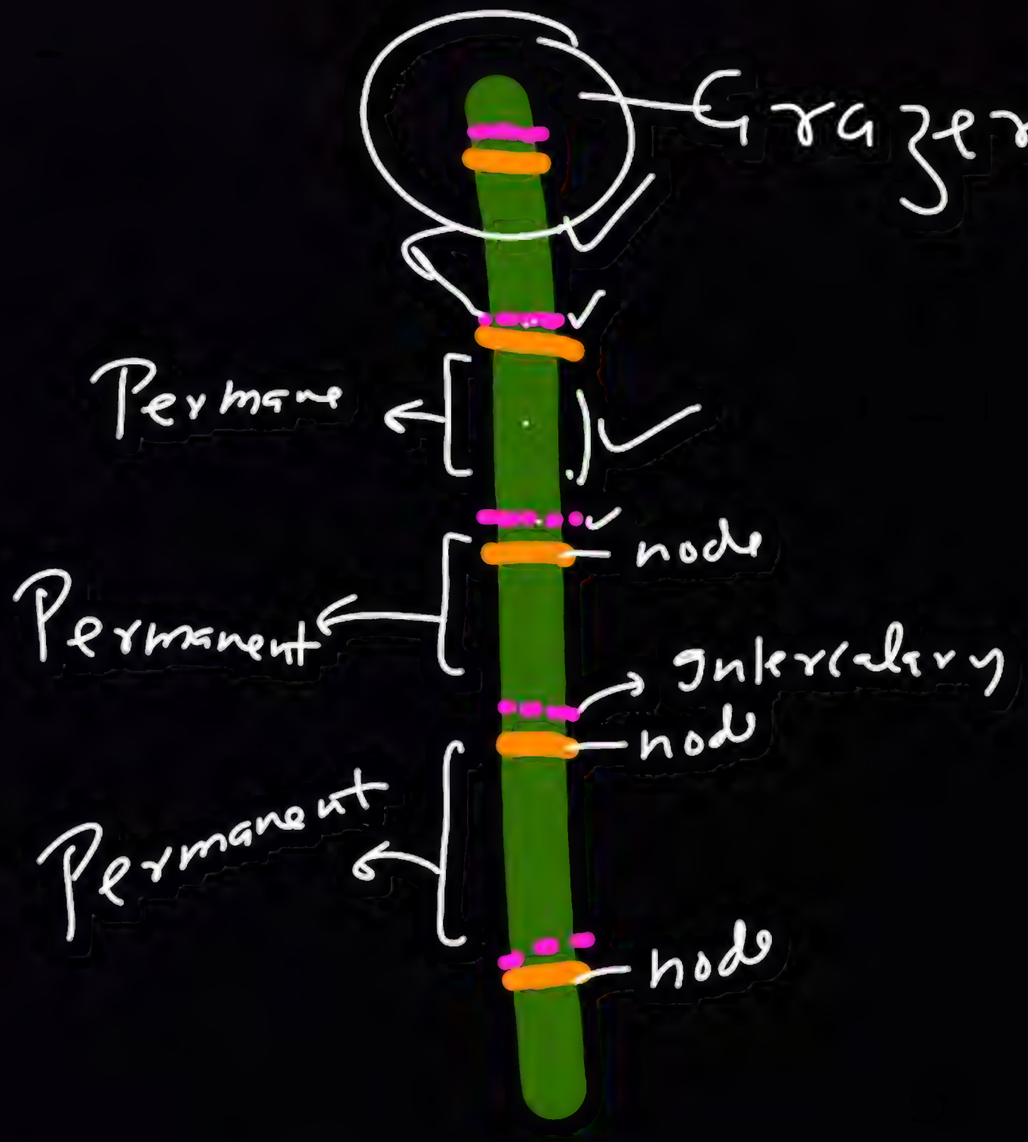
III

In Grass → (Primary)



- Intercalary Meristem – Separated By Permanent tissue
- Meristem
  - Role – Growth of internode
  - Regenerate Apical when Grazer Eat tip

IV


Grazer – Eat
Permane
node
Permanent
Intercalary
node
Permanent
node

Root apical meristem occupies the tip of a root while the shoot apical meristem occupies the distant most region of the stem axis. During the formation of leaves and elongation of stem, some cells 'left behind' from shoot apical meristem, constitute the **axillary bud**. Such buds are present in the axils of leaves and are capable of forming a branch or a flower. The meristem which occurs between mature tissues is known as **intercalary meristem**. They occur in grasses and regenerate parts removed by the grazing herbivores. Both apical meristems and intercalary meristems are **primary meristems** because they appear early in life of a plant and contribute to the formation of the primary plant body.

grazing herbivores. Both apical meristems and intercalary meristems are **primary meristems** because they appear early in life of a plant and contribute to the formation of the primary plant body.

The meristem that occurs in the mature regions of roots and shoots of many plants, particularly those that produce woody axis and appear later than primary meristem is called the **secondary** or **lateral meristem.** They are cylindrical meristems. Fascicular vascular cambium, interfascicular cambium and cork-cambium are examples of lateral meristems. These are responsible for producing the secondary tissues.

Following divisions of cells in both primary and as well as secondary meristems, the newly formed cells become structurally and functionally specialised and lose the ability to divide. Such cells are termed **permanent** or **mature cells** and constitute the permanent tissues. During the formation of the primary plant body, specific regions of the apical meristem produce dermal tissues, ground tissues and vascular tissues.

DOPA -01

Q1 Secondary Meristem derive From
(a) Epidermis (b) Procambium (c) Cortex (d) Primary Meristem

Q2 which is not product of Differentiation
(a) Pericycle (b) Cortex (c) Cork (d) Root

Q3 Product of Dedifferentiation
(a) Cortex (b) Cork cambium (c) Cortex (d) Pericycle

Q4 Lateral & secondary
(a) Cork cambium (b) Vasular cambium (c) Interfasicular (d) all

Q5 Inter cellular Space present in
(a) Apical Meristem (b) Cortex (c) Cork cambium (d) Vascular cambium

Q6 Process lead to Formation of Meristem
(a) Differentation (b) dedifferentiation (c) Redifferentiation (d) all

Q7 Epidermis is product of
(a) Differentiation (b) dedifferentiation (c) Redifferentiation (d) none

Q8 Not develop from primary Meristem
(a) Primary Xylem (b) Primary Root (c) Cork (d) Cortex

Q9 Intercalary Meristem not true
(a) Primary Growth (b) Secondary Growth (c) Monocot (d) all

Q10 Cylindrical Meristem Undergo Redifferentiation to form
(a) Cork (b) Secondary Cortex (c) SX (d) all

MANTHAN NEET 2025

SANKALP NEET VEDANTU

Anatomy of flowering plants

lecture number-02

Botany

TARUN SIR

Anatomy of Flowering plants

Topic

1. Meristimatic
2. Simple permanent tissue
3. Complex permanent tissue

New NCERT — 4, 5

Complete understanding (1, 2, 3, 4, 5)

4. Tissue System ✓
5. Section of leaf, stem & Root →
6. Secondary Growth X

Today's Goal

Meristematic tissue

Simple permanent tissue

DOPA -01

Q1 Secondary Meristem derive From → Cork Cambium — Permanent
(a) Epidermis (b) Procambium (c) Cortex (d) Primary Meristem

Q2 which is not product of Differentiation.
(a) Pericycle (b) Cortex (c) Cork (d) Root
d d Rd d

D → P.T
D.D — S.M
R.D — S.T

Q3 Product of Dedifferentiation
(a) Cortex (b) Cork cambium (c) Cortex (d) Pericycle

Q4 Lateral & secondary
(a) Cork cambium (b) Vasular cambium (c) Interfrsicular (d) all

Q5 Inter cellular Space present in
(a) Apical Meristem (b) Cortex (c) Cork cambium (d) Vascular Cambium

Q6 Process lead to Formation of Meristem
(a) Differentiation (b) dedifferentiation (c) Redifferentiation (d) all

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(a) Differentiation (b) dedifferentiation (c) Redifferentiation (d) none

Q8 Not develop from primary Meristem
(a) Primary Xylem (b) Primary Root (c) Cork (d) Cortex

Q9 Intercalary Meristem not true
(a) Primary Growth (b) Secondary Growth (c) Monocot (d) all

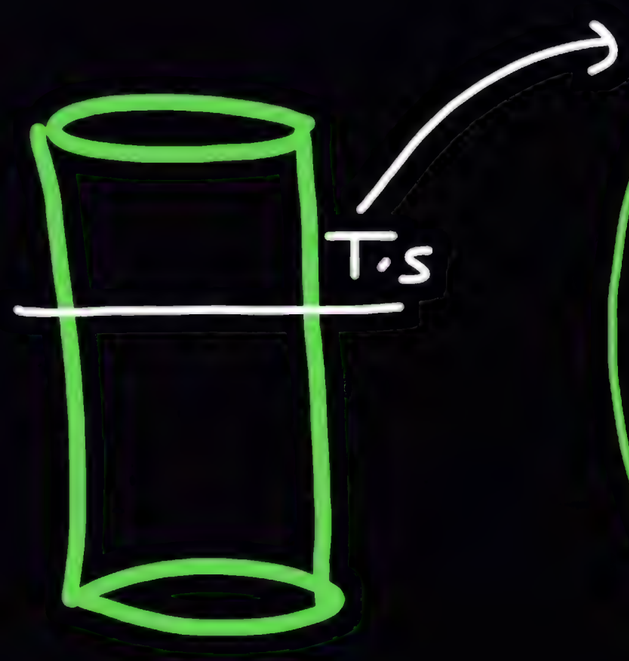
Q10 Cylindrical Meristem undergo Radifferentiation to form
(a) Cork (b) Secondary Cortex (c) SX (d) all

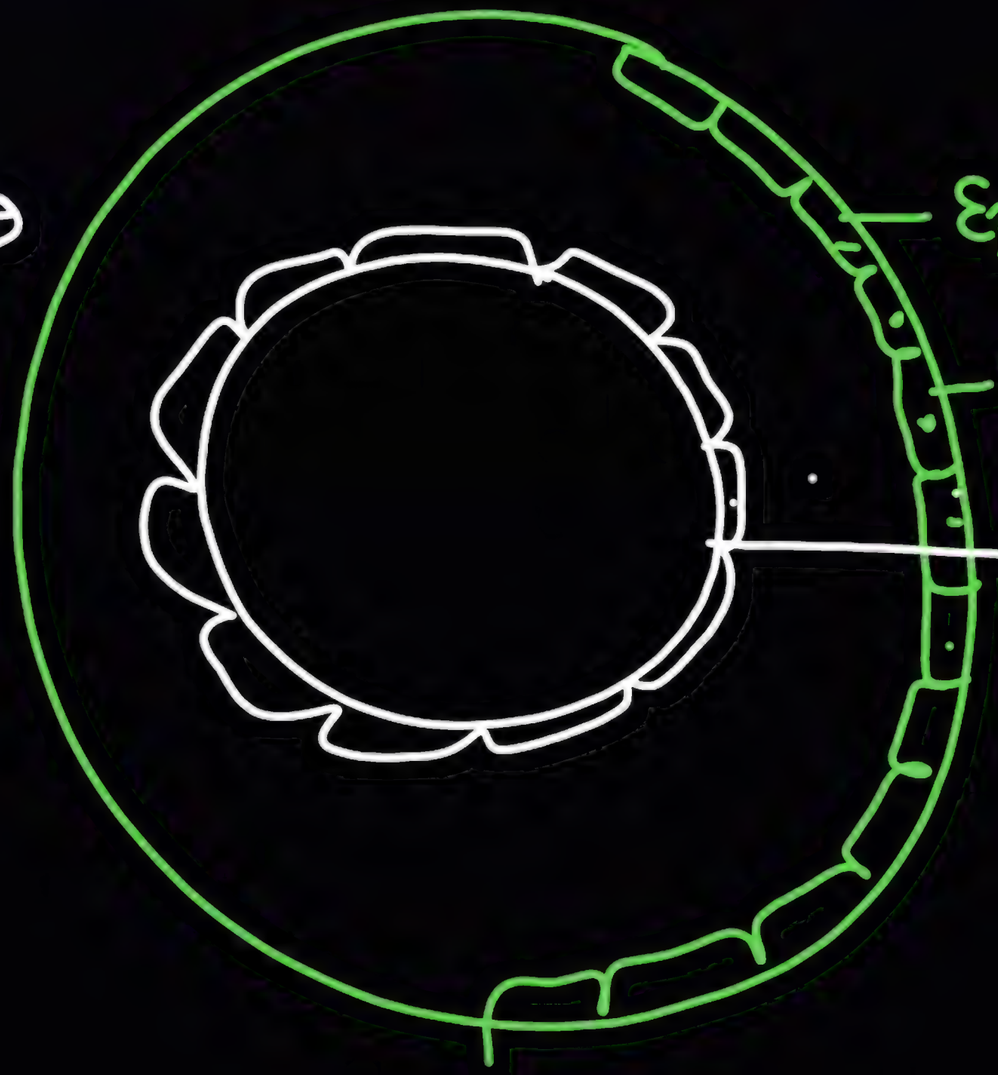
Permanent tissue

- In all plants - mainly - 4 type of cells
  - Meristimatic cells } - Part of Meristem ✓ / cambium
  - Parenchyma
  - Collenchyma
  - Sclerenchyma } - Part of permanent tissue

Permanent tissue

- Simple permanent (one type cells)
  - (a) Parenchyma tissue
  - (b) Collenchyma tissue
  - (c) Sclerenchyma tissue
- Complex permanent
  - Xylem
  - Phloem





Epidermis (Simple permanent tissue)

Parenchyma tissue

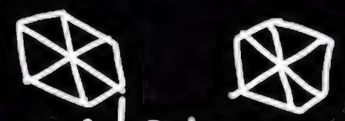
Endodermis (Parenchyma)

SANKALP NEET VEDANTU

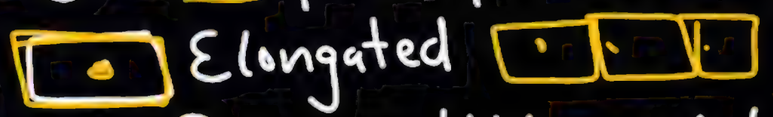
6.1.2 Permanent Tissues

The cells of the permanent tissues do not generally divide further. Permanent tissues having all cells similar in structure and function are called **simple tissues**. Permanent tissues having many different types of cells are called **complex tissues**.

Parenchyma



(1) Shape → ○ → oval | Round | Spherical | Polygonal — Isodiametric



Elongated

(2) Cell wall — Primary | thin — Mainly cellulose

(3) Intercellular space — Present

Location — Space Filling tissue ✓

Role — (a) Leaf — Photosynthesis (Chlorenchyma)

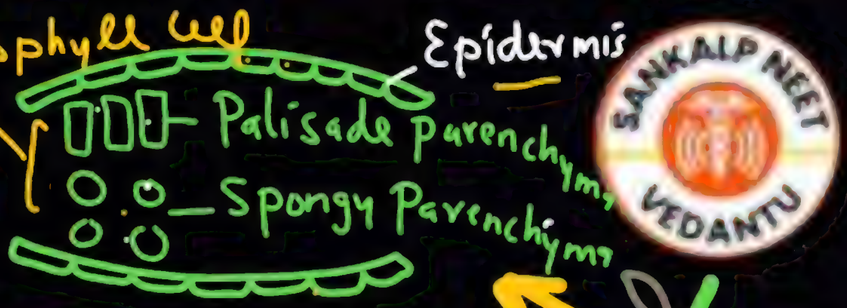
(b) Storage

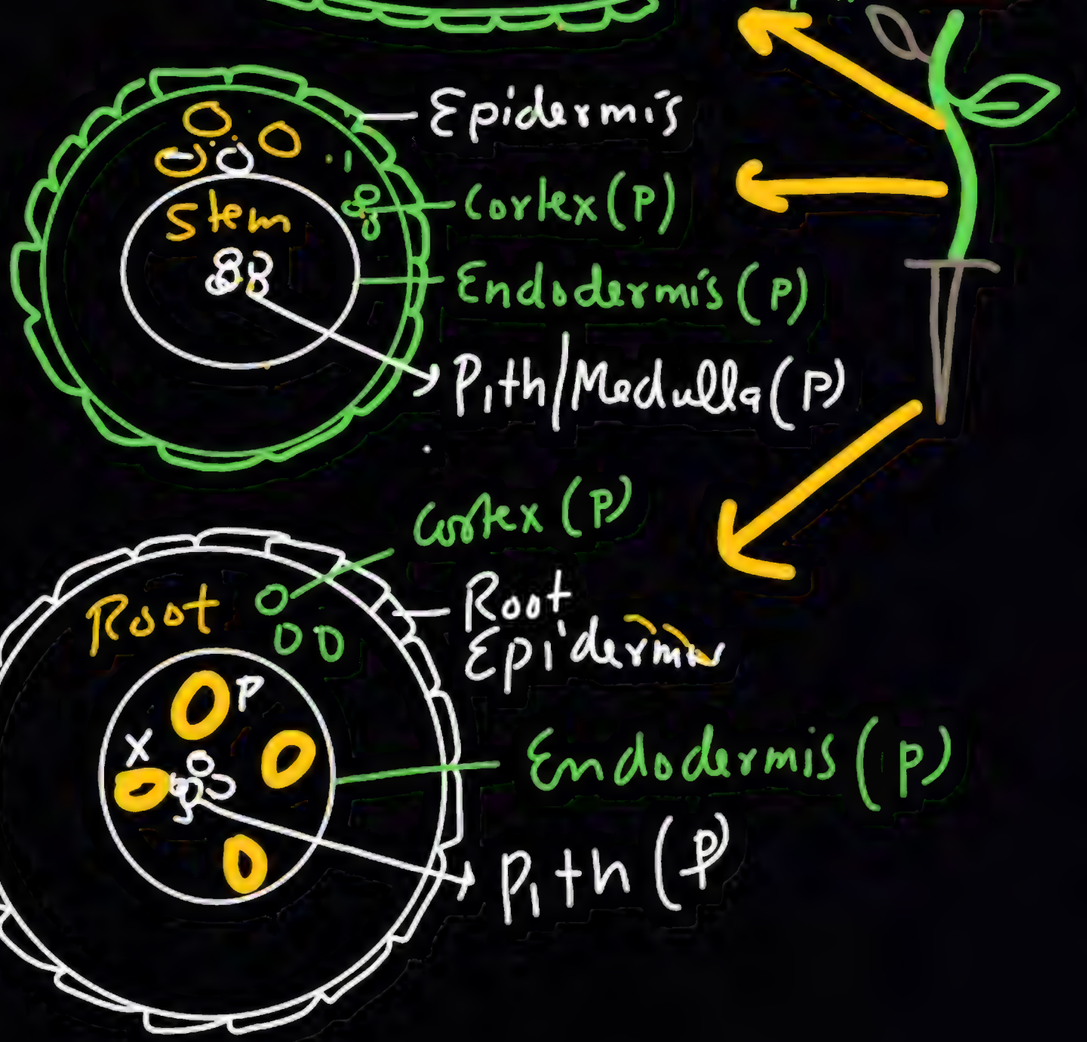
(c) Secretion

Note — no Mechanical Role

note — In leaf — Spongy & Palisade parenchyma

— Epidermis, cortex, Endodermis, Pith (Parenchyma)



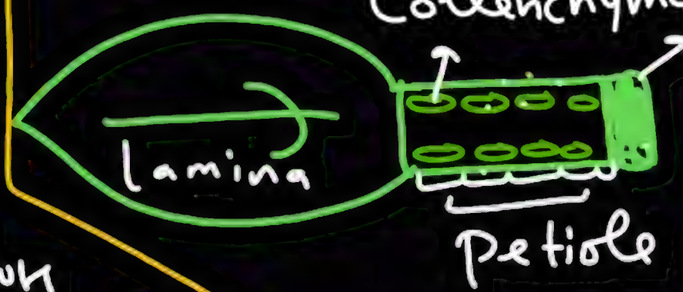


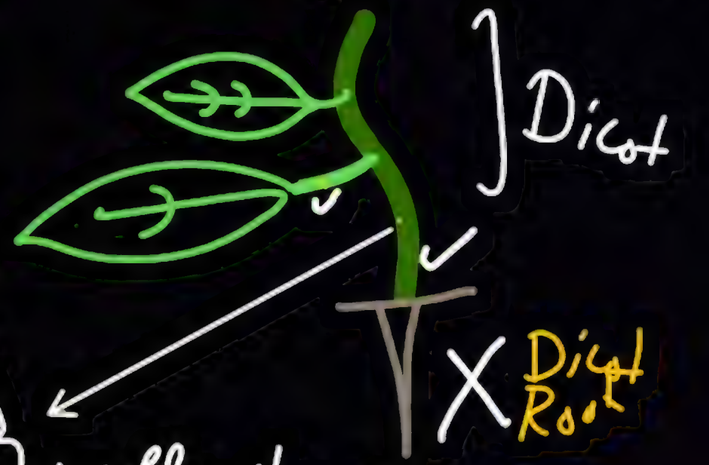
6.1.2.1 Simple Tissues

A simple tissue is made of only one type of cells. The various simple tissues in plants are parenchyma, collenchyma and sclerenchyma (Figure 6.2). **Parenchyma** forms the major component within organs. The cells of the parenchyma are generally isodiametric. They may be spherical, oval, round, polygonal or elongated in shape. Their walls are thin and made up of cellulose. They may either be closely packed or have small intercellular spaces. The parenchyma performs various functions like photosynthesis, storage, secretion.

collenchyma

Feature – living + Mechanical support
(Photosynthetic)
Intercellular - Space – Absent
Shape – Oval Spherical polygonal
deposition – Cell wall thick at some Area (cellulose + hemicellulose + pectin)
Location – Dicot plant → Stem (Just below Epidermis) (young)
→ leaf (Petiole)
→ note – they are present in uniform layer or in patches





Q Collenchyma present in

(a) Wheat leaf (monocot) ✗

(b) Neem leaf ↓ Dicot (Petiole) ✓

(c) Banyan large tree stem (Mature stem) ✗ Dicot

(d) Mustard Root (Dicot) ✓

Q Which is not part of Xylem

(a) Parenchyma (b) collenchyma (c) Sclerenchyma (d) nil

Q Location of collenchyma

(a) Pith ✗ (b) Epidermis ✗ (c) V-B (d) Cortex ✓

The **collenchyma** occurs in layers below the epidermis in most of the dicotyledonous plants. It is found either as a homogeneous layer or in patches. It consists of cells which are much thickened at the corners due to a deposition of cellulose, hemicellulose and pectin. Collenchymatous cells may be oval, spherical or polygonal and often contain chloroplasts. These cells assimilate food when they contain chloroplasts. Intercellular spaces are absent. They provide mechanical support to the growing parts of the plant such as young stem and petiole of a leaf.

Sclerenchyma

→ Shape → Elongated, Pointed Ends

→ Intercellular space - Absent

→ location → (a) Part of Xylem & Phloem - as Fibre

(b) Other than Xylem & Phloem present

(Hypodermis of Monocot stem
Pericycle of Dicot stem)

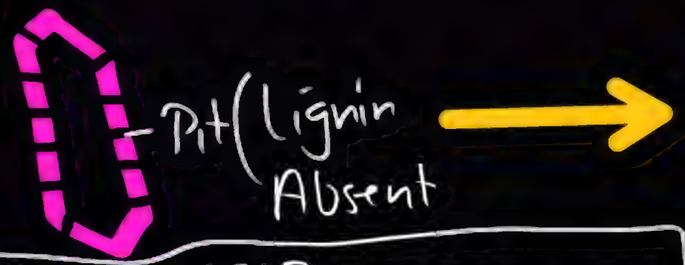
Cell Become dead

dead cell
(lignified wall)
no plasma membrane

tracheids

dead cell, lignified

what is Pit



- Pit (Lignin Absent)

On the Basis of F O S D
Form, origin, structure, Development

Two type of sclerenchyma

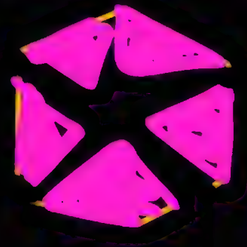
Fibre

- Elongated & tapering End
- Mechanical support

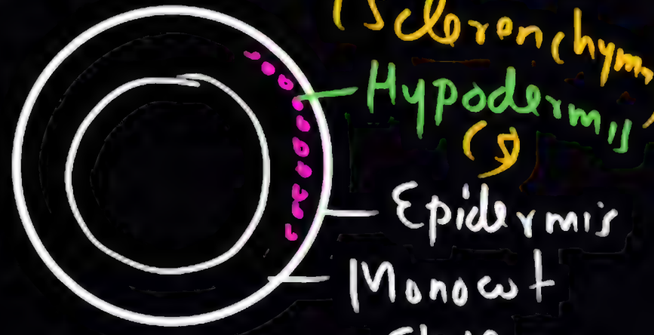
Part of Xylem & Phloem (Present in V.B)

- Pericycle of Dicot stem
- Hypodermis monocot stem

Sclereids



- Polygonal or Rod shape
- Highly thickened wall
- hardness → Ex - Gritiness in Pulp of Pear & Guava & Sapota
  - tea leaf
  - legume (seed coat)



Sclerenchyma consists of long, narrow cells with thick and lignified cell walls having a few or numerous pits. They are usually dead and without protoplasts. On the basis of variation in form, structure, origin and development, sclerenchyma may be either fibres or sclereids. The **fibres** are thick-walled, elongated and pointed cells, generally occuring in groups, in various parts of the plant. The **sclereids** are spherical, oval or cylindrical, highly thickened dead cells with very

narrow cavities (lumen). These are commonly found in the fruit walls of nuts, pulp of fruits like guava, pear and sapota, seed coats of legumes and leaves of tea. Sclerenchyma provides mechanical support to organs.

DOPA - 02

Q1 Mechanical role have
(a) Parenchyma (b) collenchyma (c) Sclerenchyma (d) both b & c

Q2 not Feature of sclerenchyma
(a) dead (b) thick cell wall (c) living cell (d) lignified

Q3 Similarity B/w parenchyma & collenchyma
(a) intercellular space present (b) no deposition in cell wall (c) Can be Photosynthetic (d) Mechanical

Q4 In Plants, most number of ___ tissue
(a) Parenchyma (b) Monosimatic (c) collenchyma (d) Sclerenchyma

Q5 collenchyma Absent in
(a) Root (b) Monocot (c) Vascular Bundle (d) all

Q6 Pits are present in
(a) tracheids (b) Fibre (c) Sclerenchyma (d) all

Q7 Pulp of pear, sapota & Guava have
(a) Fibre (b) tracheids (c) sclereids (d) all

Q8 Meristimatic cell Absent in
(a) Xylem (b) Phloem (c) Epidermis (d) all

Q9 Tracheary Element not have Feature
(a) Pitted (b) lignified (c) living (d) dead

Q10 Tracheary Element Absent in Pinus
(a) Parenchyma (b) Vessels (c) tracheids (d) Sieve tube

Q11 Exarch Xylem not true
(a) Present in stem (b) Protoxylem outside (c) Metaxylem towards pith (d) Present in Grass stem

Q12 true For Grass → (a) Exarch in Root (b) Endarch in stem
(c) Collenchyma Absent (d) all

cell theory

cell theory

cell theory

MANTHAN NEET 2025

Anatomy of flowering plants

lecture number- 03

Botany

TARUN SIR

Anatomy of Flowering plants

Topic

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2. Simple permanent tissue
3. Complex permanent tissue

New NCERT — 4, 5

Complete understanding (1, 2, 3, 4, 5)

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5. Section of leaf, stem & Root →
6. Secondary Growth X

Today's Goal

Meristematic tissue

Simple permanent tissue

DOPA – 02

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(a) Parenchyma (b) Vessels (c) tracheids (d) Sieve tube

Q11 Exarch Xylem not true
(a) Present in stem (b) Protoxylem outside (c) Metaxylem towards pith (d) Present in Grass stem

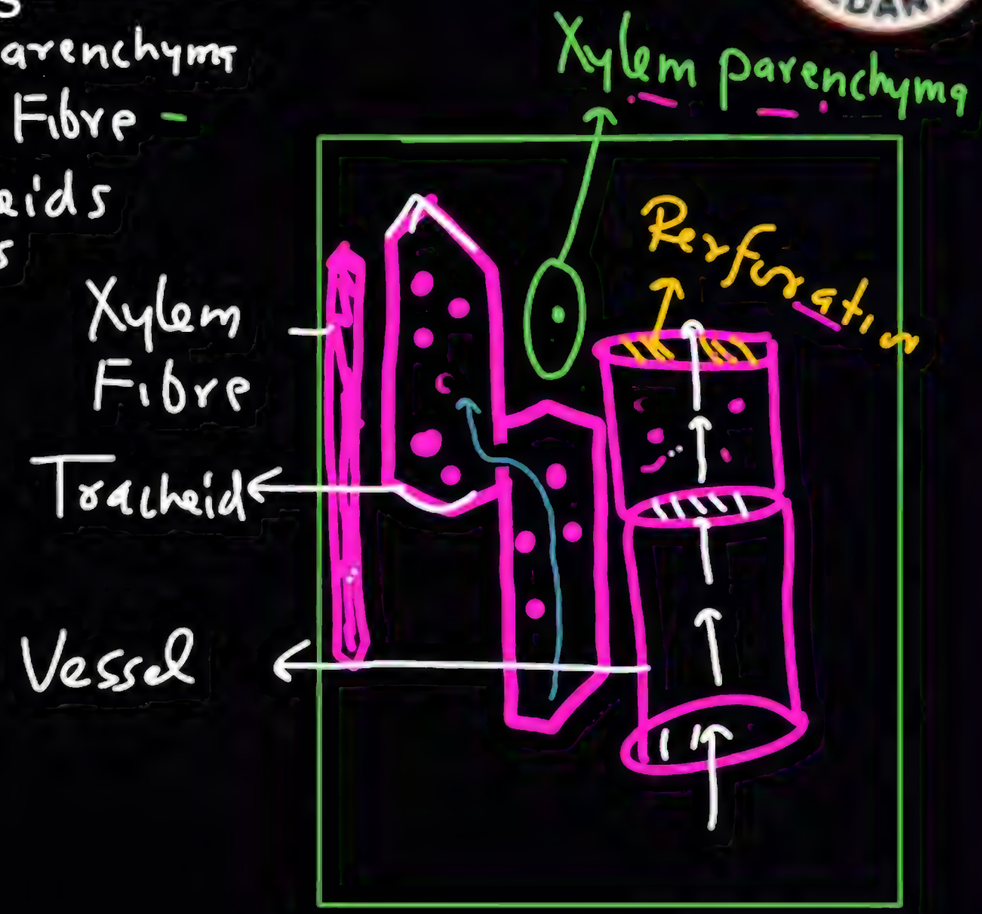
Q12 true For Grass → (a) Exarch in Root (b) Endarch in stem
(c) Collenchyma Absent (d) all

Xylem

Complex permanent tissue

Type of cells – 4 type of cells
(a) Xylem parenchyma
(b) Xylem Fibre –
(c) tracheids
(d) Vessels

- Lignified dead cells → 3 (Except Xylem parenchyma) — 3 (living cell = 1)
- Mechanical support → mainly Fibre (Xylem Fibre) But vessels & tracheids also
- water transport → tracheids, Vessels ⊣ Tracheary Element
- Perforated (End wall pore) → Vessels ✓
- Pitted → Fibre, Vessels, Tracheids



How Xylem develop

Xylem Parenchyma – Role – Radial conduction
Storage – tannin, Starch & oil]

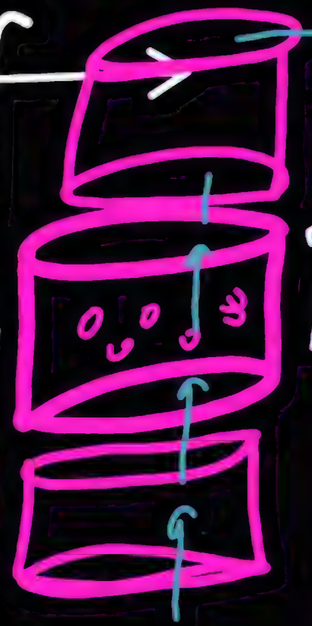
Meristem

– Xylem Fibre – Elongated, Pointed End, Lignified, dead cells (lignin Fill in Lumen – obliterated (lumen)
Role – Mechanical support (Septate & Aseptate

(Different type of tracheids)

– Amount of Deposition Different
– lignified, Lumen Empty
– Imperforated (no Perforation

Vessel
– Perforation present
– drum shape



} 1 cell – Vessel Element

Type of Xylem

① Primary Xylem

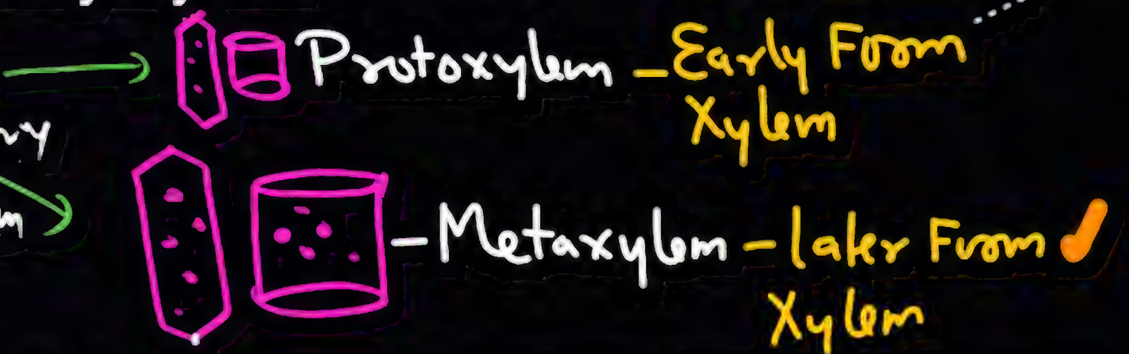
Primary Meristem → Protoxylem – Early Form Xylem

Primary Meristem → Metaxylem – later Form Xylem

② secondary Xylem

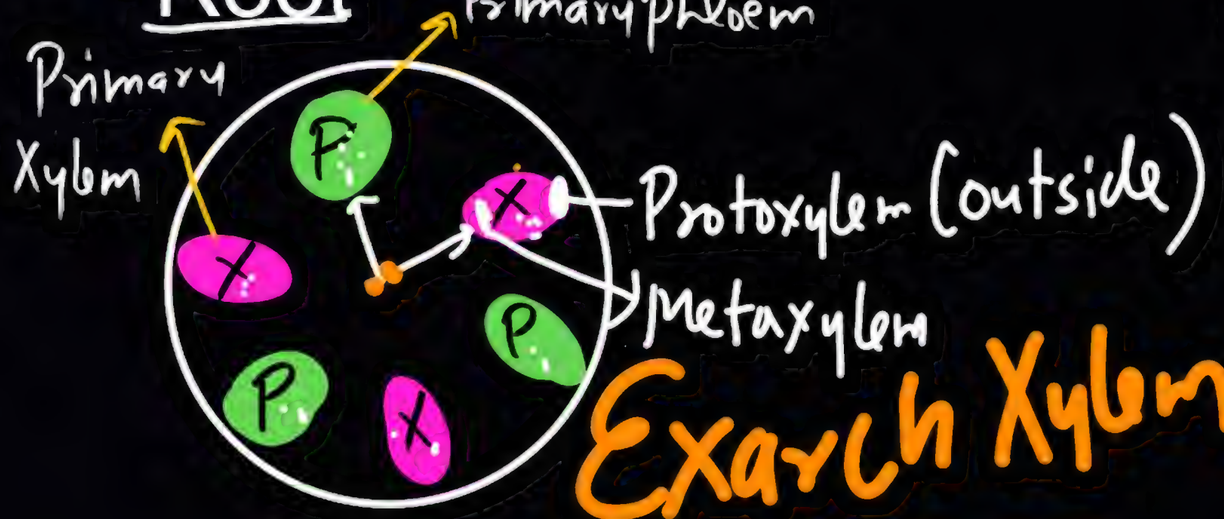
From ih (Dicot stem, Dicot Root)

Secondary Meristem (Vascular Cambium)



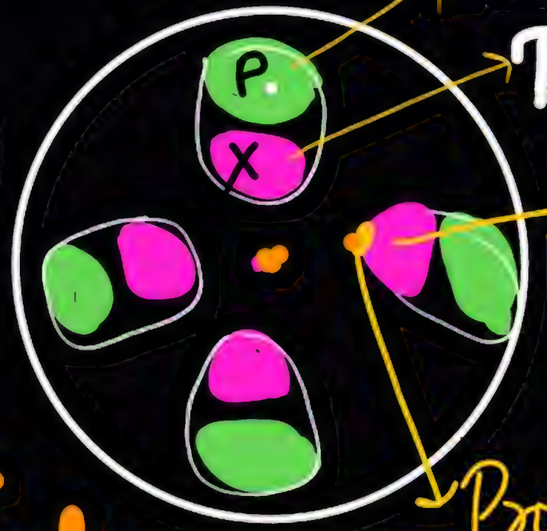
(Radial Bundle)

Root



Exarch Xylem

stem



Primary Phloem

Primary Xylem

Metaxylem (outer

Protoxylem – inner

Endarch Xylem

Phloem – Transport – Food, some mineral

- Phloem parenchyma
- Phloem Fibre
- Sieve tube
- Companion cell

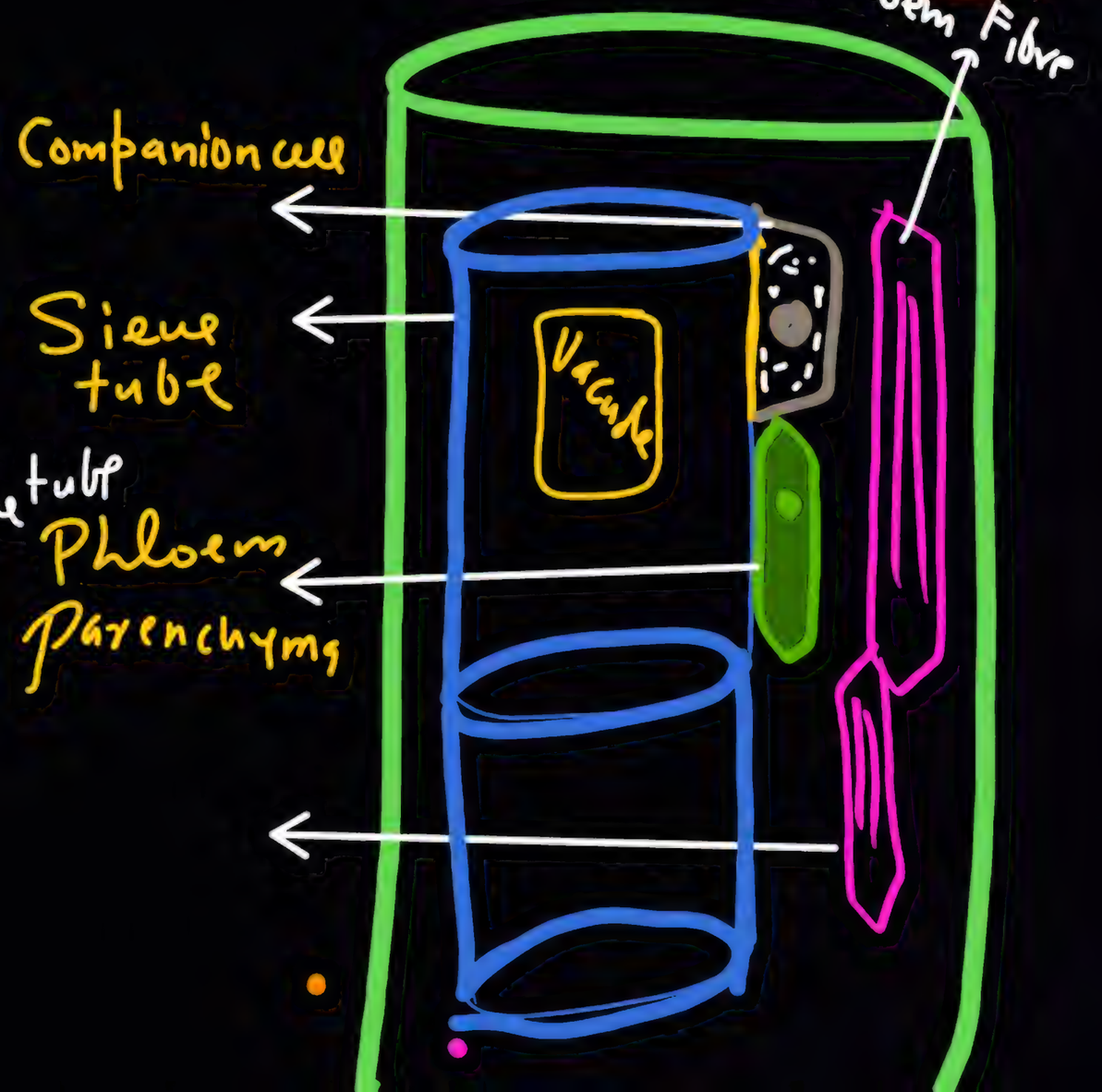
no. of cells – 4 type cells →

living cells → 3 (Phloem Fibre – dead)

Dead cells → 1

Mechanical Support = 1 cell (Fibre)

Gymnosperm – Sieve cell – in place of sieve tube
– Albuminous cell in place of Companion cell



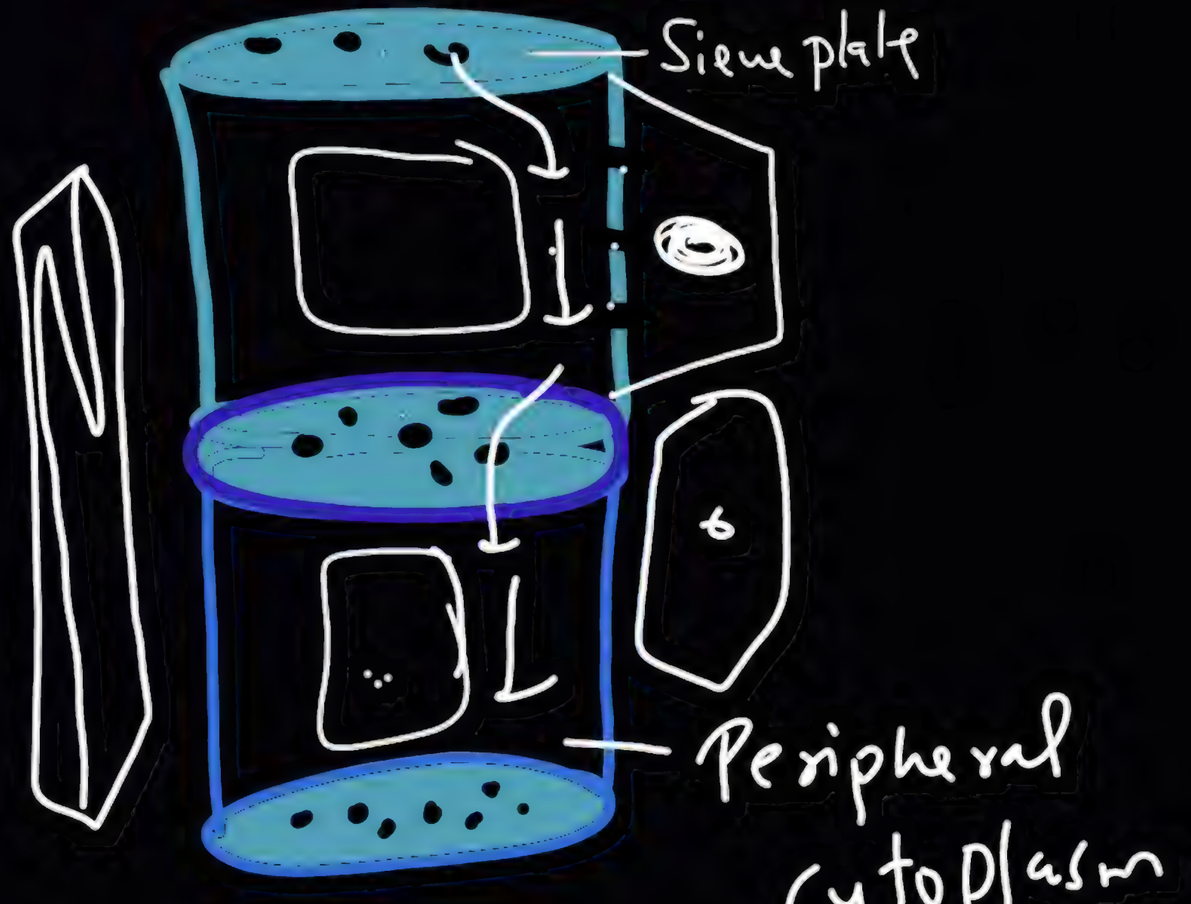
Sieve tube and companion cell

1. **Sieve tube** – made up of many Sieve member
– End wall – Sieve plate → have Sieve pore
→ nucleus Absent, large central vacuole

2. companion cell → nucleus present, lateral wall large no. of Plasmodesmata connection with Sieve tube – **Pit Fields**
– Control Activity of Sieve tube
(help to maintain pressure in sieve tube

3. **Phloem Fibre** – Provide support, Lignified (Use as a Commercial Fibre (Jute, Flax, hemp)
note – Phloem Fibre present only in Secondary Phloem

4. **Phloem parenchyma** – thick wall, Elongated
Role → Storage → Resins, gums & mucilage
note – Phloem Parenchyma Absent in monocot

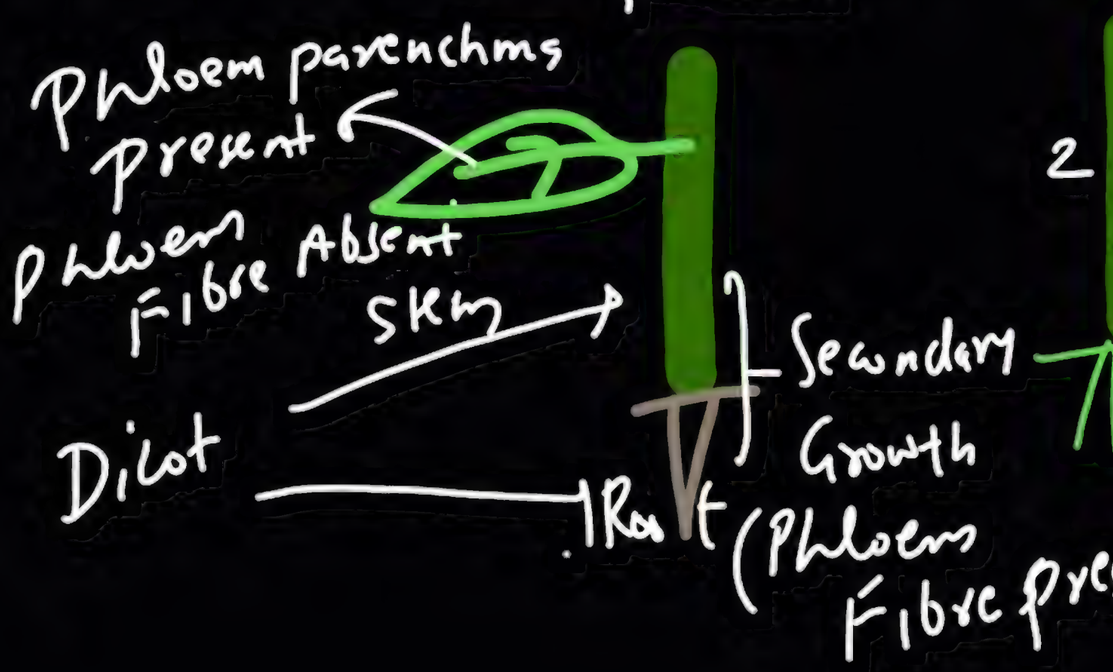

Sieve plate
Peripheral
Cytoplasm

Type of phloem

Primary Phloem – Develop from primary meristem → Protophloem – Early develop Phloem
→ Metaphloem – late develop phloem

Secondary Phloem → Develop from Secondary Meristem

Q1 Absent in Dicot leaf
(a) Protoxylem (b) Metaphloem (c) Secondary Phloem (d) All



Monocot
(all 4 typed cell)
Primary Xylem
Primary phloem
(Phloem X
Fibre
Phloem X
Parenchyma

	Primary Xylem (Proto, Meta) Vessels, Tracheids, Xylem Fibre, Xylem Parenchyma	Secondary Xylem	Primary phloem (Proto, Meta) Sieve tube, Companion cell, Phloem parenchyma	Secondary phloem Sieve tube, Companion cell, Phloem parenchyma, Phloem Fibre :-
Dicot - Stem	✓	✓	✓	✓
Dicot Root	✓	✓	✓	✓
Dicot leaf	✓	✗	✓	✗
Monocot stem	✓	✗	✓	✗
Monocot Root	✓	✗	✓	✗
Monocot leaf	✓	✗	✓ (no phloem parenchyma)	✗

Phloem Fibre present in
~~(a)~~ Banyan Root
(b) Mustard Leaf

[(c) Maize Stem
(d) Maize Root

MANTHAN NEET 2025

Anatomy of flowering plants

lecture number- 04

Botany

TARUN SIR

Anatomy of Flowering plants

Topic

1. Meristimatic
2. Simple permanent tissue
3. Complex permanent tissue

New NCERT — 4, 5

Complete understanding (1, 2, 3, 4, 5)

4. Tissue System ✓
5. Section of leaf, stem & Root →
6. Secondary Growth X

cell theory

Tissue System →

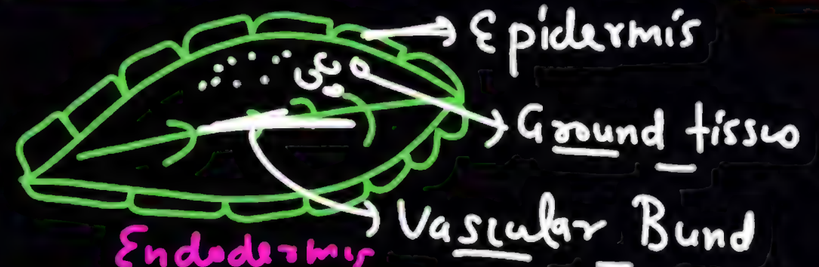
- Classification of tissue → one the Ability to Divide → (Meristimatic, Permanent)
- Another classification → on the Basis of location based Function

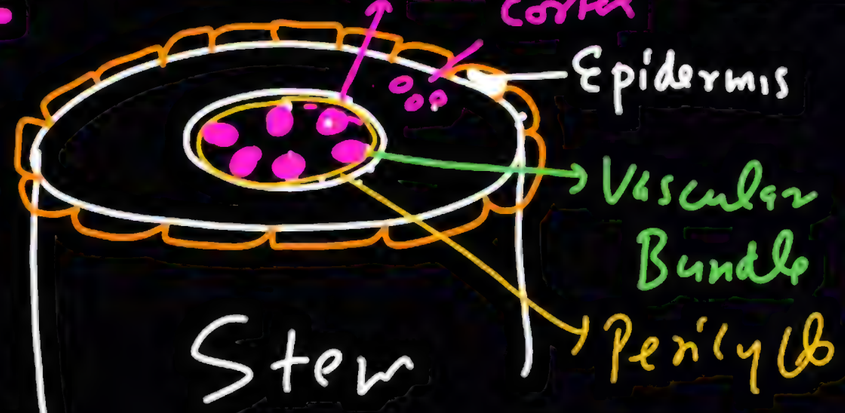
Primary organs – Root, Stem, Leaf → on the Basis of location Three type of tissue

(a) Epidermal tissue – Protection

(b) Vascular tissue → Conduction of Food & water

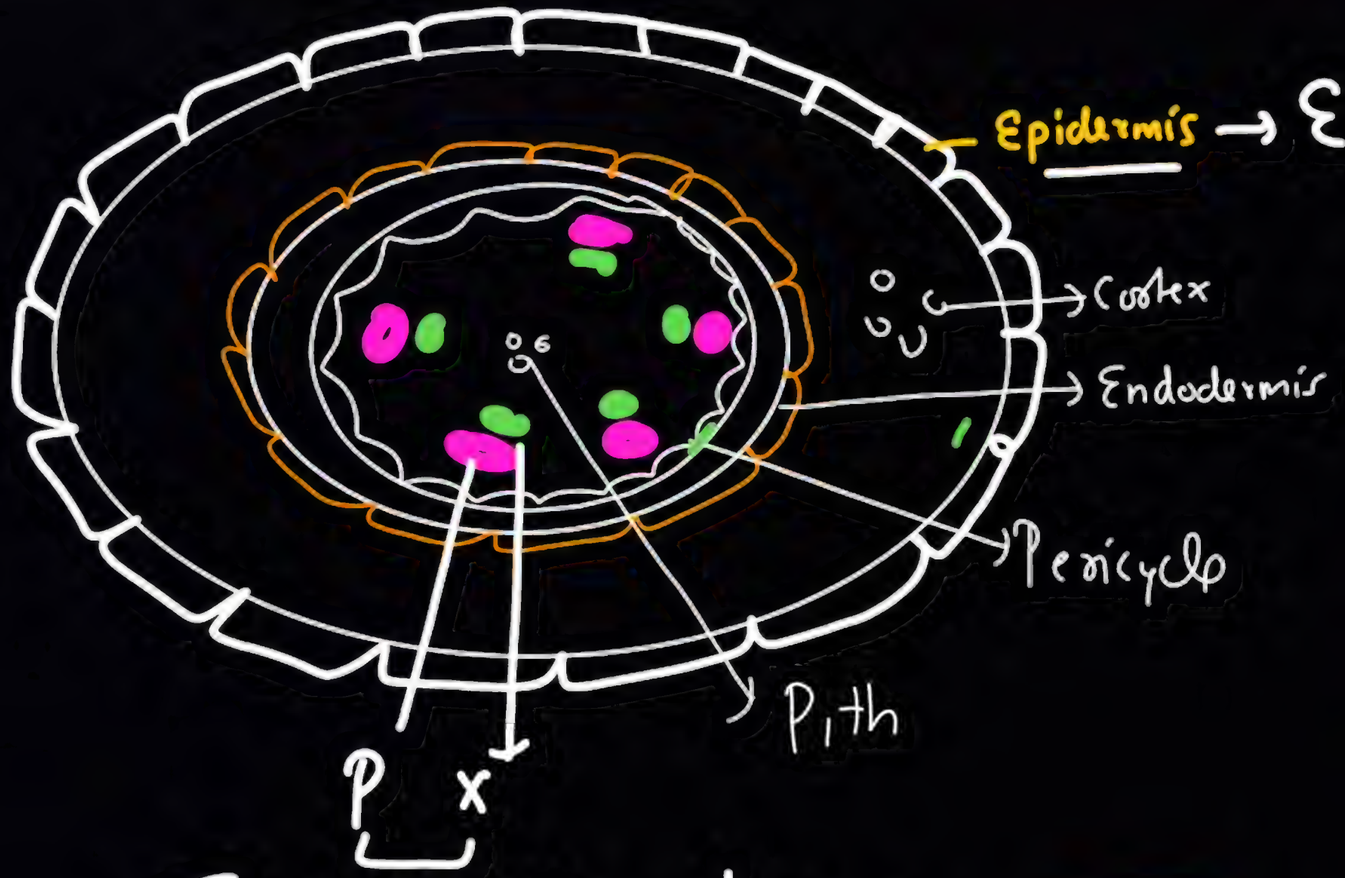
(c) Ground tissue → T.S minus Epidermis & Vascular tissue





6.1 The Tissue System

We were discussing types of tissues based on the types of cells present. Let us now consider how tissues vary depending on their location in the plant body. Their structure and function would also be dependent on location. On the basis of their structure and location, there are three types of tissue systems. These are the epidermal tissue system, the ground or fundamental tissue system and the vascular or conducting tissue system.



Epidermis → Epidermal tissue – (1)

Cortex
Endodermis
Pericycle
Pith
} Ground tissue (Parenchyma, Collenchyma, Sclerenchyma)

all three type cells can be possible

II Vascular tissue

Q Which is part of Epidermal tissue

(a) Primary Xylem (b) Cortex (c) Guard cell (d) Pith

stomata

X X X

Tissue system

Epidermal

Feature
- Root Epidermis
- Stem Epidermis
- leaf Epidermis

Vasular Bundle

- Xylem & Phloem Arrangment

Ground tissue

- T.S - Epidermis - V.B

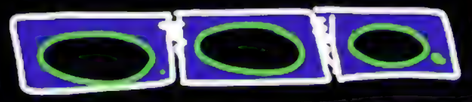
Ex - Cortex, pith, pericycle, Endodermis (Root & stem)

- leaf (Mesophyll cell → Dicot)
  - Spongy Parenchyma
  - palisade parenchyma

6.1.1 Epidermal Tissue System

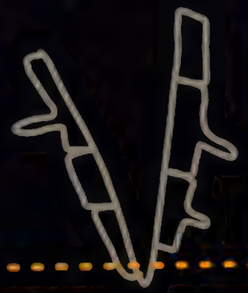
Feature → Plants primary organ – outermost layer – Known as Epidermal tissue / Epidermis

(a) Unilayer – Single layer
(b) Cells – Parenchyma
(c) large vacuole, less cytoplasm
(d) Elongated cells → Very less intercellular Space present
(e) Also have Different structure (Appendage) & Adaptation



Structures on Epidermis

(a) Cuticle – Wax layer on Aerial Part of plant (Stem & Leaf) (Prevent water loss)
(b) Stomata → Gaseous Exchange & transpiration control
(c) Root hair → Water Absorb
(d) Trichome → Prevent transpiration
(e) Lenticels → Pore → Stem, Root (When Secondary Growth occur) → present in → Cork layer

	Root Epidermis	Stem Epidermis	Leaf Epidermis
			
(a) Cuticle →	X	✓	✓
(b) Root hair	✓	X	X
(c) Stomata	X	✓ (Green stem young stem)	✓
(d) Trichome	X	✓	✓
(e) Lenticel →	Dicot Root (Secondary Growth)	Dicot Stem	X

Shoot (Stem + Leaf)

Q- Cuticle ✓, Lenticel X, Stomata, trichome
How many present in Young Stem
(a) two (b) three (c) Four
(d) none

Stomata → – Present on leaf Epidermis & young stem

Stomatal Apparatus ⇒ Guard cell + Subsidiary cell + Stomatal Pore
↳ help in transpiration ↳ Loss of Water in Gas Form

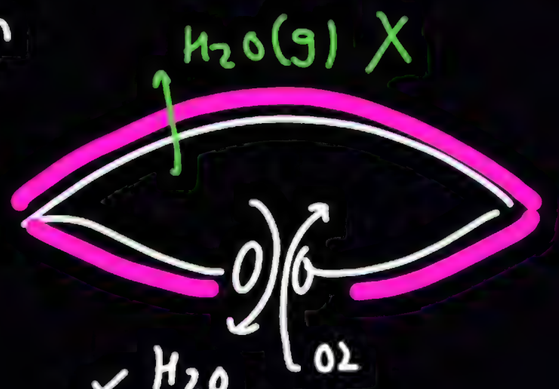
– Guard cells (Inner wall – thick, Outer wall – thin)
– Dicot – Bean shape
– Only Epidermal cells having Chloroplast
– Chloroplast help in opening & closing of stomata

Monocot → Guard cell – Dumbell Shape

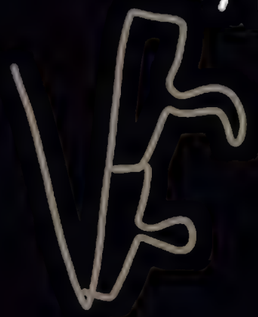
Trichome - Hair like structure on Shoot (Stem + Leaf)

- Multicellular
- Branch or Unbranch
  → Soft & Stiff
- Can be secretory

Role - Prevent transpiration



Root hair	Trichome
Location → Root	- Stem + Leaf
→ Absorption	— Secretion + Prevent transpiration
+ Unicellular Outgrowth	— Multicellular

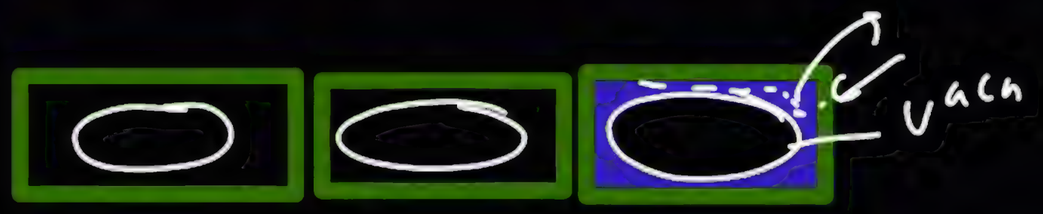


Epidermal tissue

The epidermal tissue system forms the outer-most covering of the whole plant body and comprises epidermal cells, stomata and the epidermal appendages – the trichomes and hairs. The **epidermis** is the outermost

. The **epidermis** is the outermost layer of the primary plant body. It is made up of elongated, compactly arranged cells, which form a continuous layer. Epidermis is usually single-layered. Epidermal cells are parenchymatous with a small amount of cytoplasm lining the cell wall and a large vacuole. The outside of the

Root, stem, leaf



cytoplasm lining the cell wall and a large vacuole. The outside of the epidermis is often covered with a waxy thick layer called the **cuticle** which prevents the loss of water. Cuticle is absent in roots. **Stomata** are structures present in the epidermis of leaves. Stomata regulate the process of transpiration and gaseous exchange. Each stoma is composed of two bean-

Many - stomata
Single - stoma

Each stoma is composed of two bean-shaped cells known as **guard cells** which enclose stomatal pore. In grasses, the guard cells are dumb-bell shaped. The outer walls of guard cells (away from the stomatal pore) are thin and the inner walls (towards the stomatal pore) are highly thickened. The guard cells possess chloroplasts and regulate the opening and closing of stomata. Sometimes, a few epidermal cells, in the vicinity of the guard cells become specialised in their shape and size and are known as **subsidiary cells**. The stomatal aperture, guard cells and the surrounding subsidiary cells are together called **stomatal apparatus** (Figure 6.1).

The cells of epidermis bear a number of hairs. The **root hairs** are unicellular elongations of the epidermal cells and help absorb water and minerals from the soil. On the stem the epidermal hairs are called **trichomes**. The trichomes in the shoot system are usually multicellular. They may be branched or unbranched and soft or stiff. They may even be secretory. The trichomes help in preventing water loss due to transpiration.

Q Not part of Epidermal tissue

Guard cell, Stomata, Xylem, Pith, Phloem fibre, Guard cells

(a) two (b) three (c) Four (d) Five

Q S-I Role of Epidermal tissue is protection

S-II Epidermal tissue help in water Absorption & transpiration

cell theory

Q3 Cells of Epidermis
(a) Parenchyma (b) Collenchyma (c) Sclerenchyma (d) all

Q4 Epidermis cell not have Feature
(a) large vacuole (b) Single layer (c) Compactly Arrange (d) loosely Arrange

Q5 Shape of Epidermal cells
(a) Oval (b) Round (c) Elongated (d) none

cell theory

Q Cuticle is present on all Except

(a) Petiole (b) lamina (c) Stem (d) Root

Q Role of cuticle

(a) Prevent loss of water in Aerial part

(b) Prevent loss of water in all part of plant

Q Gaseous Exchange By

(a) Stomata (b) Cuticle

Q Stomata present on

(a) Leaf (b) Stem (c) Root (d) Both a & b

Q1 S-I all Epidermal cells have chloroplast in leaf
S-II Guard cells have Chloroplast

Q2 Opening of Stomata Regulate By _____ organelle in guard cell
(a) ER (b) Golgi (c) Chloroplast (d) none

Q3 S-I Stomatal Apparatus cells are Epidermal cells
S-II Stomatal Apparatus present in Dicot not monocot

Q Bean shape Guard cell in all Except

(a) Wheat (b) Mustard (c) Mango (d) Bean

Q Subsidiary cell

I Epidermal cell

II Not have chloroplast

III Specialised shape

IV Specialised size

(a) I & II (b) II & III (c) I, II & III (d) all Four

cell theory

Q Trichome located on

(a) Stem (b) Leaf (c) Shoot (d) Root

Q Similarity B/w trichome & Root hair

(a) Epidermal (b) Branched (c) Prevent transpiration

(d) all

Q S-I → Trichome can be Soft & stiff

S-II – Root hair prevent transpiration

cell theory

Ground tissue

All tissues except epidermis and vascular bundles constitute the **ground tissue**. It consists of simple tissues such as parenchyma, collenchyma and sclerenchyma. Parenchymatous cells are usually present in cortex, pericycle, pith and medullary rays, in the primary stems and roots. In leaves, the ground tissue consists of thin-walled chloroplast containing cells and is called **mesophyll**.

Q Cells present in Ground tissue

(a) Parenchyma (b) Collenchyma (c) Sclerenchyma (d) all

Q Not part of Ground tissue

(a) Trichome (b) pith (c) Cortex (d) Endodermis

Q In leaf Ground tissue mainly

(a) Pith (b) Guard cell (c) Mesophyll cell (d) all

cell theory

Q Few Ex Given

pith, Cortex, trichome, Xylem parenchyma, Phloem parenchyma

Guard cell, Xylem Fibre, Endodermis

How many not Ground tissue

cell theory

Vascular tissue system

→ Xylem and phloem together called vascular Bundle

→ Type of vascular Bundle

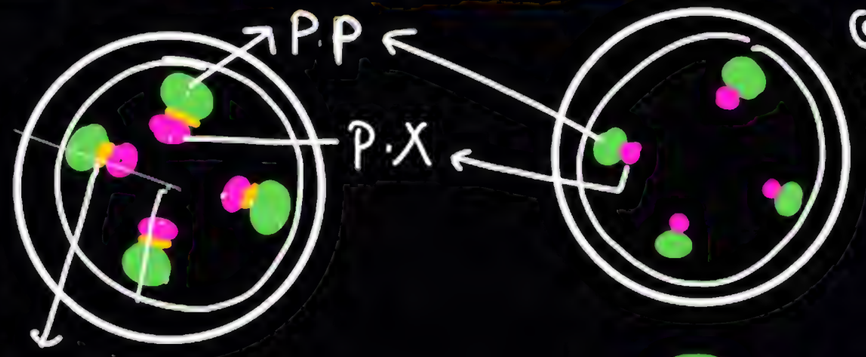
(a) Radial – Present in Dicot Root & Monocot Root

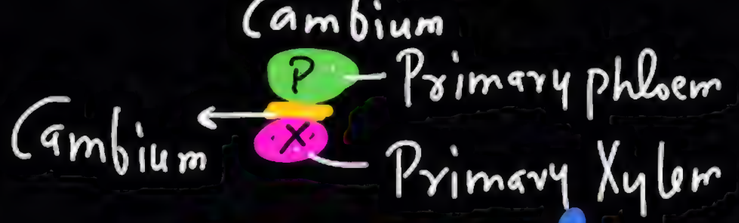
Xylem & Phloem on Alternate Radius

1: Dicot Root (less Bundle)

2. Monocot Root (large no of Bundle

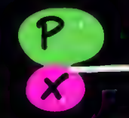
(b) Conjoint → Xylem & Phloem on Same Radius → two type (a) open (b) close





Open Bundle

(3. Dicot stem)



No cambium

Close Bundle

(4. Monocot stem

5. Monocot leaf

6 Dicot leaf

MANTHAN NEET 2025

Anatomy of flowering plants

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Guard cell, Stomata, Xylem, Pith, Phloem fibre, Guard cells

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& transpiration

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I Epidermal cell

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III Specialised shape

IV Specialised size

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cell theory

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(a) Epidermal (b) Branched (c) Prevent transpiration

(d) all

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S-II – Root hair prevent transpiration

cell theory

Q Cells present in Ground tissue

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Q Not part of Ground tissue

(a) Trichome (b) pith (c) Cortex (d) Endodermis

Q In leaf Ground tissue mainly

(a) Pith (b) Guard cell (c) Mesophyll cell (d) all

cell theory

Q Few Ex Given

pith, Cortex, trichome, Xylem parenchyma, Phloem parenchyma

Guard cell, Xylem Fibre, Endodermis

How many not Ground tissue

cell theory

Vascular tissue system

→ Xylem and phloem together called vascular Bundle

→ Type of vascular Bundle

(a) Radial – Present in Dicot Root & Monocot Root

Xylem & Phloem on Alternate Radius

1: Dicot Root (less Bundle)

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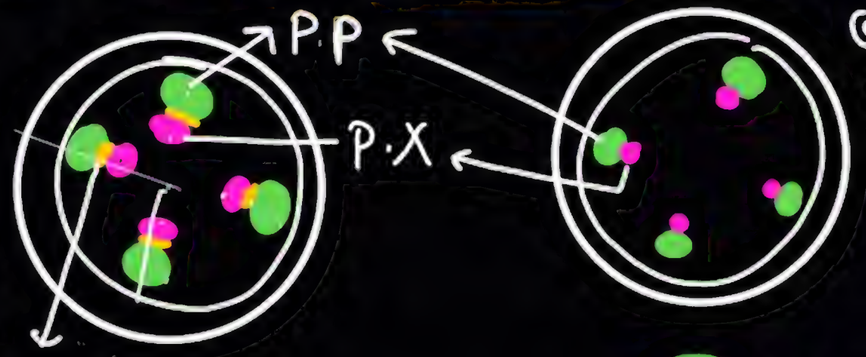
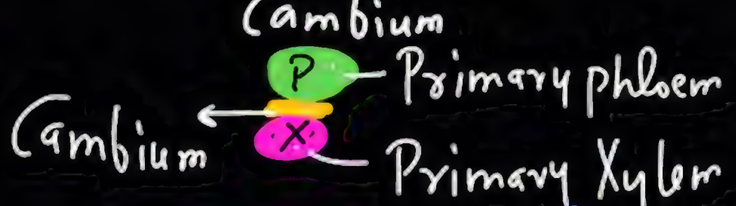
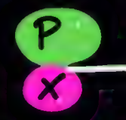




Open Bundle

(3. Dicot stem)



No cambium

Close Bundle

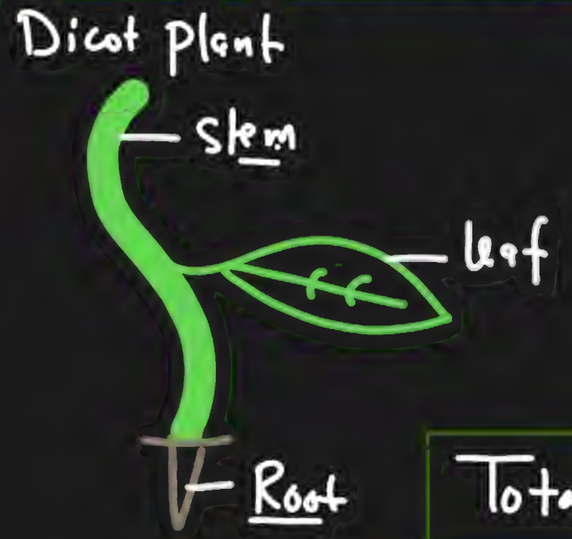
(4. Monocot stem

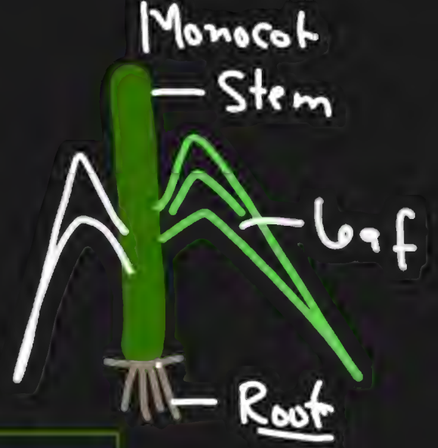
5. Monocot leaf

6 Dicot leaf

cell theory

sections of Plant part





Total Six Sections

Transverse Section
- (a) Dicot Root (tap Root)
- (b) Monocot Root (Fibrous)
- (c) Dicot Stem
- (d) Monocot Stem

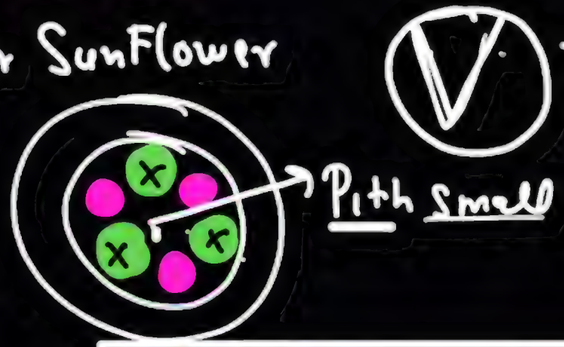
Vertical Section
- (e) Dicot leaf - Dorsiventral leaf
- (f) Monocot leaf - Isobilateral

6.2 Anatomy of Dicotyledonous and Monocotyledonous Plants

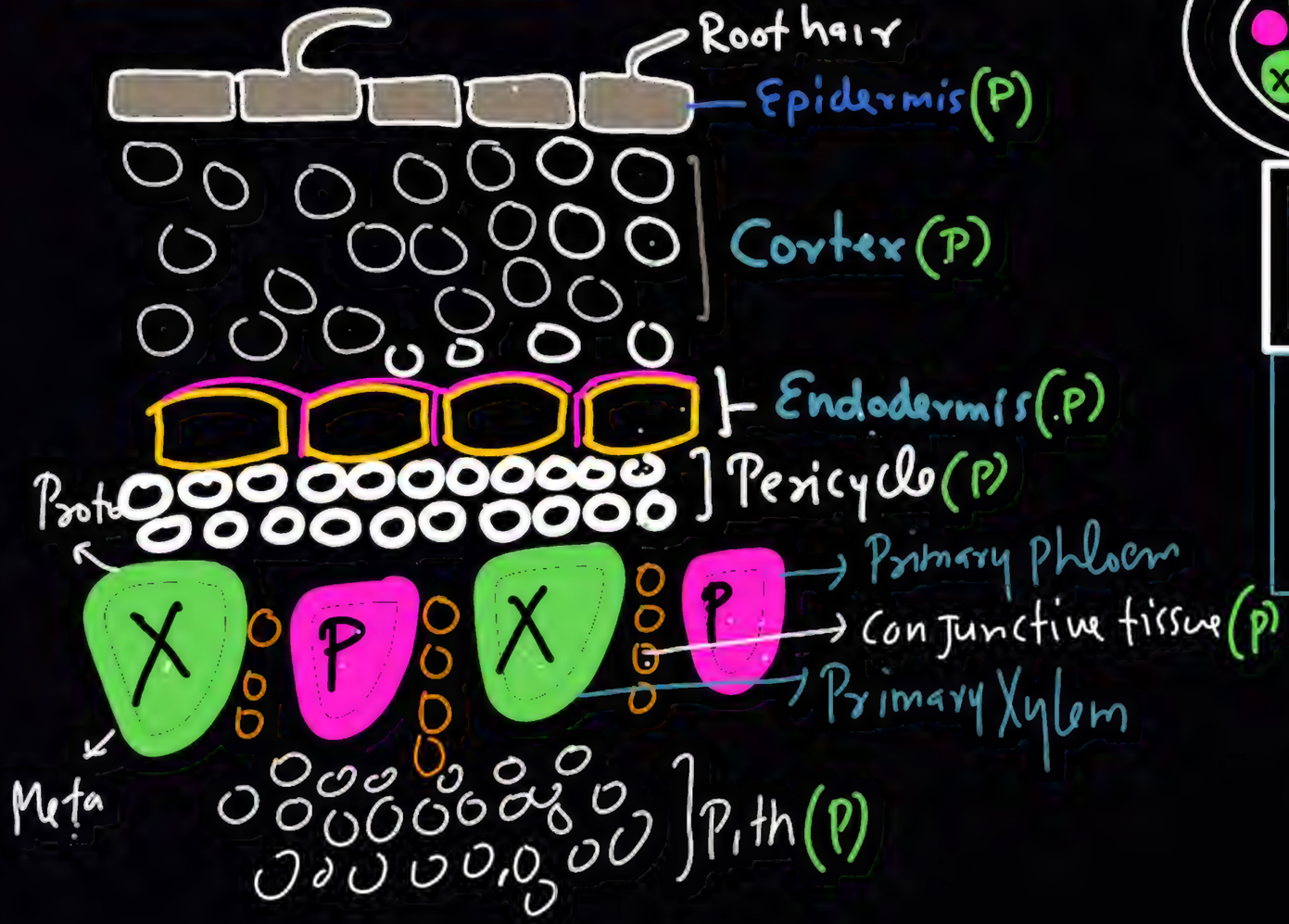
For a better understanding of tissue organisation of roots, stems and leaves it is convenient to study the transverse sections of the mature zones of these organs.

Dicot Root

– Section study of Mustard or SunFlower



Transverse Section



Ground tissue = T.S – Epidermis – V.B
Cortex, Endodermis, Pericycle, pith, Conjunctive tissue

Stele → all tissue inner to Endodermis
– Pericycle, pith, Conjunctive tissue, Vascular Bundle

note – Ground tissue of Dicot Root have only parenchyma

Epidermis – Parenchyma, Elongated shape, no intercellular space, no cuticle
– Root hair present → Epidermis also known as Epiblema

Cortex – Parenchyma, inner to Epidermis
– B/w Epidermis & Pericycle
Cortex two part
(a) – Cortical cells – cell wall thin, Intercellular space present
(b) Endodermis – Barrel shape
– Suberin on tangential & Radial wall

Pericycle – Parenchyma, thick wall, Few layer
– two Role of pericycle → (a) It Form Branch
(b) It Form Cambium (For Secondary Growth)

Vascular Bundle → Radial (X & P on Different Radii)
→ Exarch – Protoxylem – outer side, Metaxylem towards pith
→ 2 to 6 Xylem & Phloem

Pith → Parenchyma
→ Small/inconspicuous in Dicot Root
→ Intercellular space Can present

Conjunctive tissue → Parenchyma B/w Xylem & Phloem

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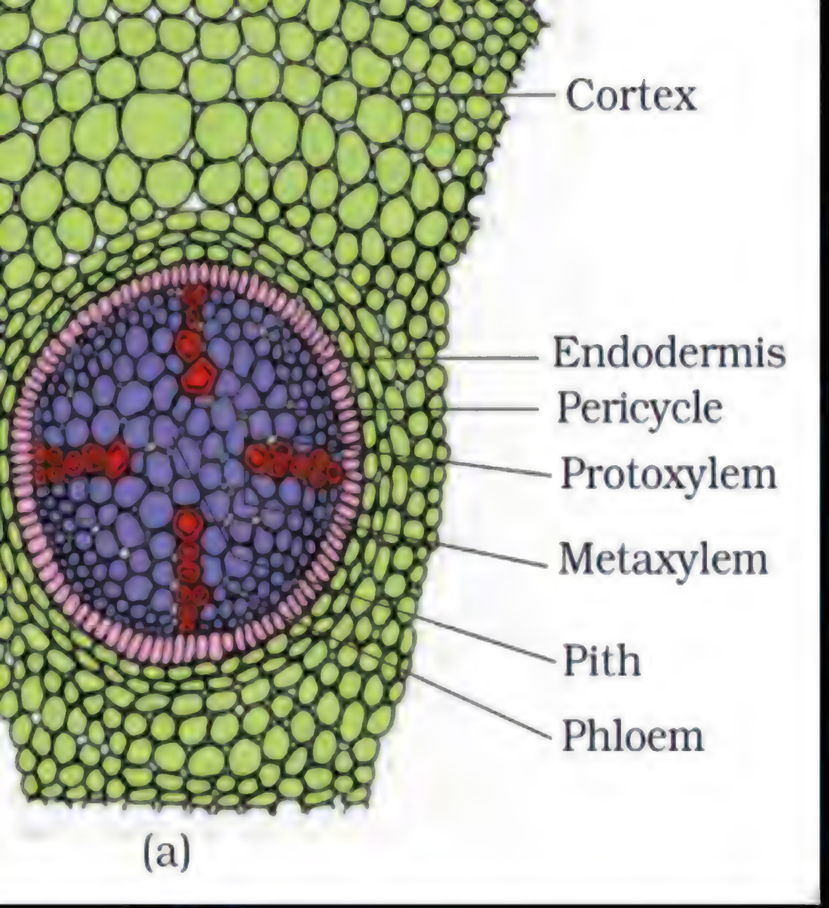


(a)

S-I Ground tissue of Dicot Root have only parenchyma → Endo, Cortex, Pith, Pericycle

S-II Stele have only parenchyma ✗
↳ also have V.B → Fibre present → Sclerenchyma

Q Part of Ground tissue which is not stele →
(a) Pericycle (b) Pith (c) Endodermis (d) Primary Xylem

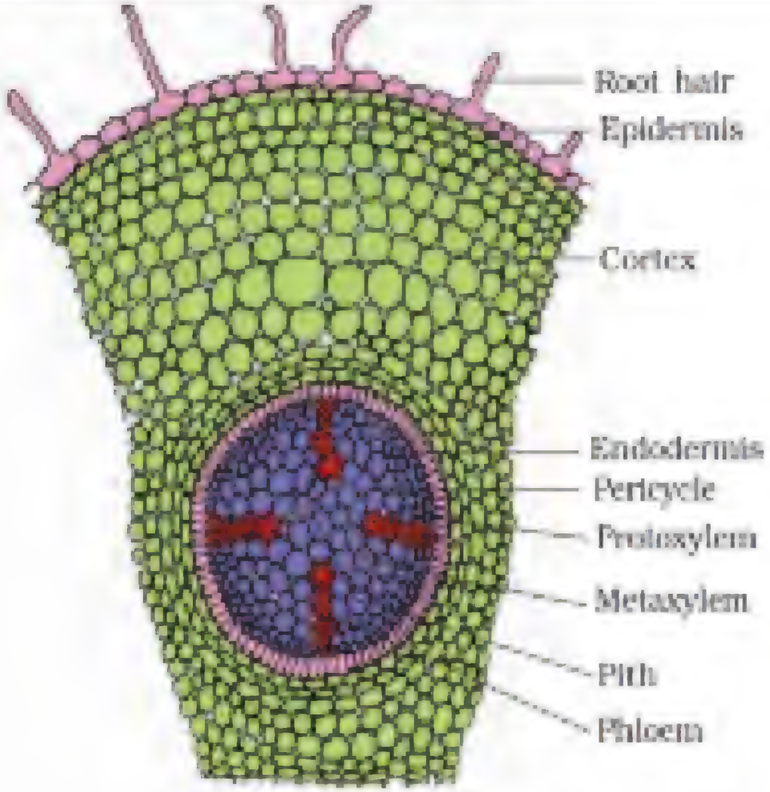
Q Part of stele which is not part of Ground tissue
(a) Root hair ✗ (b) Protoxylem (c) Pith (d) Pericycle → Part of Both

Q Which is present in Dicot Root, not part of Stele as well as Ground tissue
(a) Pericycle (b) Primary Phloem (c) Root hair (d) Pith

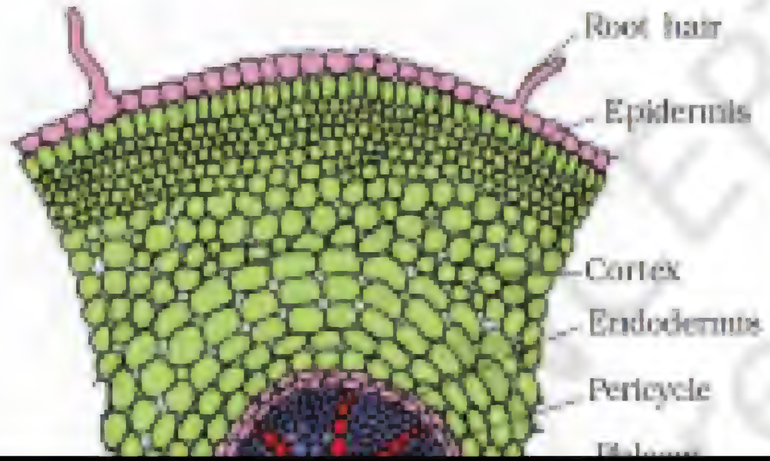
6.2.1 Dicotyledonous Root

Look at Figure 6.3 (a), it shows the transverse section of the sunflower root. The internal tissue organisation is as follows:

The outermost layer is **epiblema.** Many of the cells of epiblema protrude in the form of unicellular root hairs. The **cortex** consists of several layers of thin-walled parenchyma cells



(a)



with intercellular spaces. The innermost layer of the cortex is called **endodermis**. It comprises a single layer of barrel-shaped cells without any intercellular spaces. The tangential as well as radial walls of the endodermal cells have a deposition of water impermeable waxy material suberin in the form of **casparian strips**. Next to endodermis lies a few layers of thick walled parenchymatous cells referred to as **pericycle**. Initiation of lateral roots and vascular cambium during the secondary growth takes place in these cells. The pith is small or inconspicuous. The parenchymatous cells which lie between the xylem and the phloem are called **conjuctive tissue**. There are usually two to four xylem and phloem patches. Later, a cambium ring develops between the xylem and phloem. All tissues on the innerside of the endodermis such as pericycle, vascular bundles and pith constitute the **stele**.

Monocot Root

– Monocot Root and Dicot Root Anatomy Same

Epidermis, Cortex, Endodermis, Pericycle, Pith, Vascular Bundle present

Dicot Root

Pericycle – Root Branch & Cambium Form (Secondary Growth occur)

Pith small

Vascular Bundle less

Monocot Root

Endodermis

Vascular Bundle – large in number

(More than Six Xylem) – Polyarch

– No secondary Growth ✓

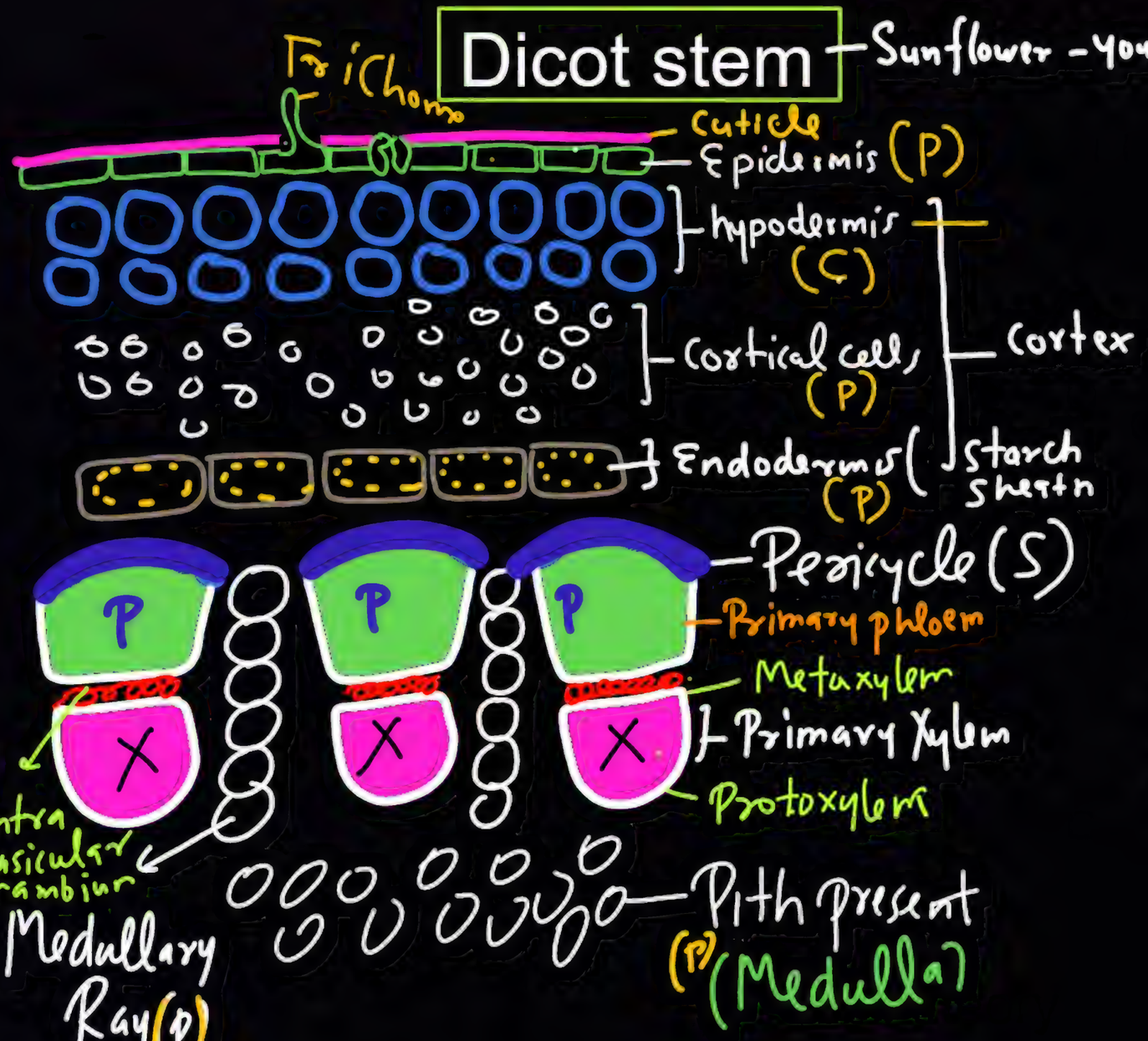
– Pith large ✓

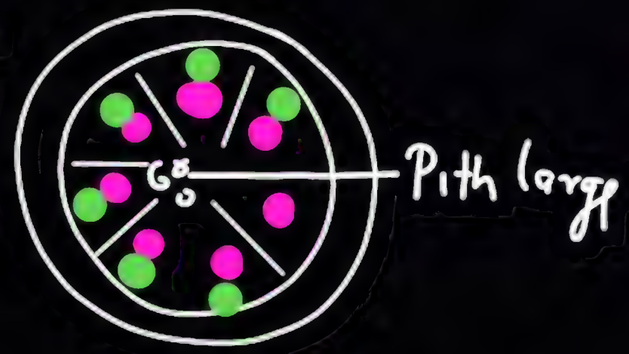
6.2.2 Monocotyledonous Root

The anatomy of the monocot root is similar to the dicot root in many respects (Figure 6.3 b). It has epidermis, cortex, endodermis, pericycle, vascular bundles and pith. As compared to the dicot root which have fewer xylem bundles, there are usually more than six (polyarch) xylem bundles in the monocot root. Pith is large and well developed. Monocotyledonous roots do not undergo any secondary growth.

Dicot stem

Sunflower - young stem





Ground tissue → T.S - E - V.B

hypodermis(c) + cortical cells (P) + Endodermis + Pericycle(s) + pith (P) + Medullary Rays (P)

Note - Ground tissue of Dicot stem Parenchyma, Collenchyma & Sclerenchyma

Epidermis – Single layer, Parenchyma, thin cuticle, may be → Trichome & Stomata (Very less)

Cortex B/w Pericycle & Epidermis → Cortex
Divided into three zone → (a) hypodermis – Collenchyma cells, Mechanical support
(b) Cortical cells – parenchyma, intercellular space
(c) Endodermis → Starch grain present (starch sheath present)

Pericycle – Sclerenchyma
Present in Semi lunar patch

Vascular Bundle → Conjoint – Xylem & Phloem same Radius
→ Open – Cambium present B/w Phloem & Xylem (Intrafasicular Cambium)
→ Trinangular and Present in Ring (Eustele)
→ Endarch → Protoxylem towards pith

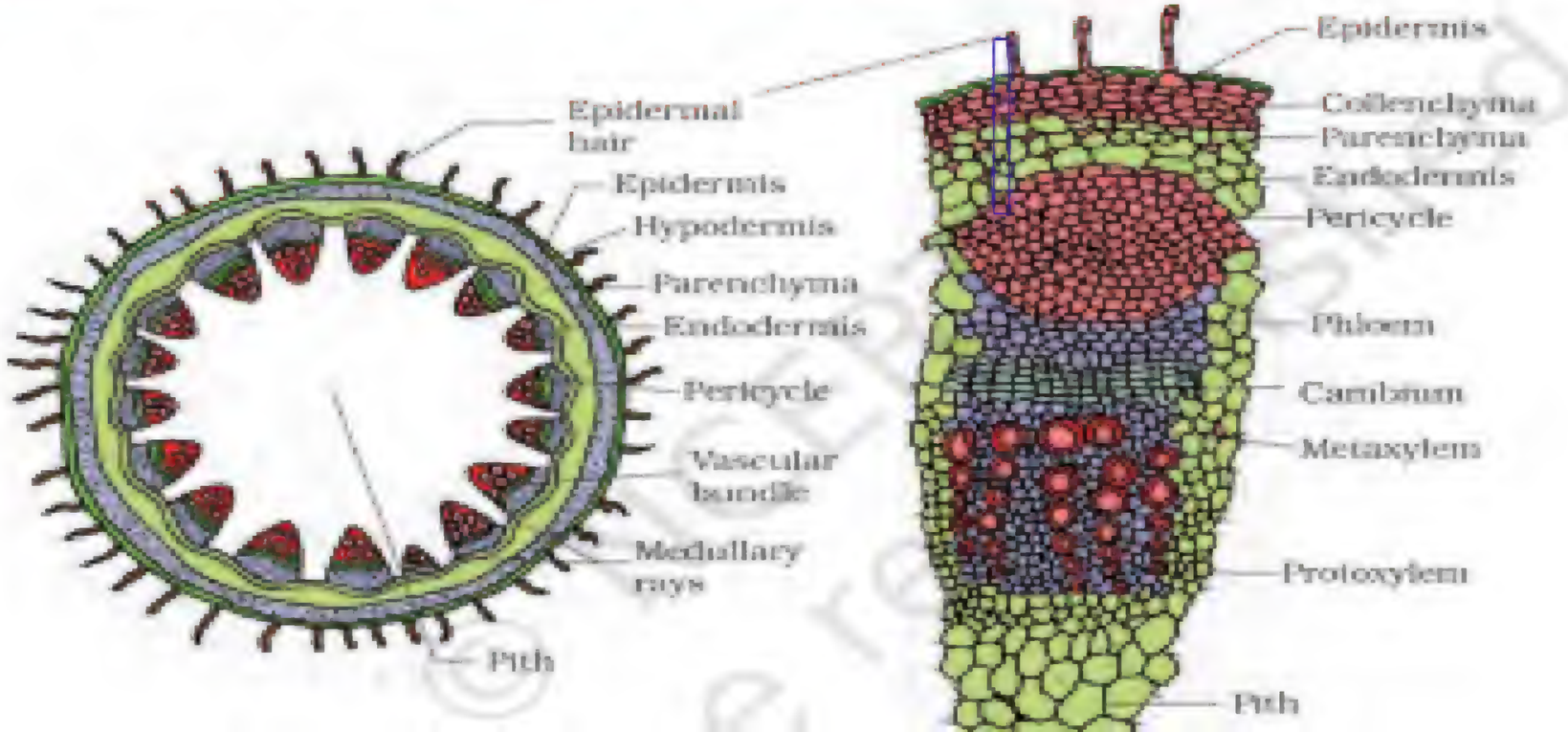
– Pith (Parenchyma) – large
– Medullary Rays – Parenchyma cells Arrange Radially

Ⓟ Endarch, Conjoint open
(a) Dicot stem (b) Dicot Root
(c) Dicot leaf (d) Monocot Root

S-I Sclerenchyma present in pericycle of Dicot stem
S-II Sclerenchyma absent in (Primary Xylem) Dicot Root ✗

6.2.3 Dicotyledonous Stem

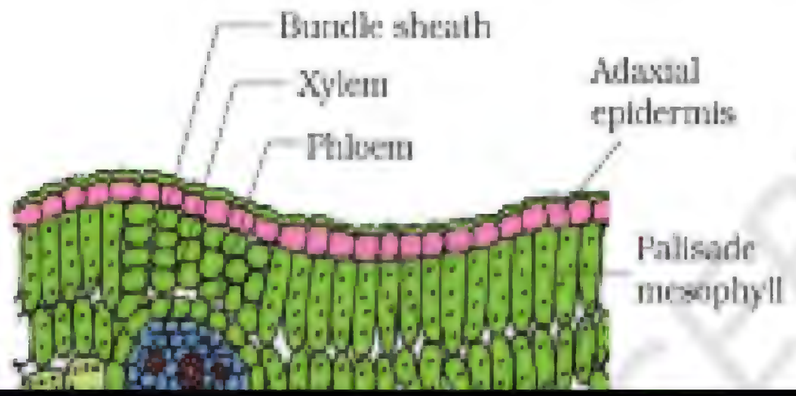
The transverse section of a typical young dicotyledonous stem shows that the **epidermis** is the outermost protective layer of the stem [Figure 6.4 a]. Covered with a thin layer of cuticle, it may bear trichomes and a few stomata. The cells arranged in multiple layers between epidermis and pericycle constitute the cortex. It consists of three sub-zones. The outer **hypodermis**, consists of a few layers of collenchymatous cells just below the epidermis, which provide mechanical strength to the young stem. **Cortical layers** below hypodermis consist of rounded thin walled parenchymatous cells with conspicuous intercellular spaces. The innermost layer of the cortex is called the **endodermis**. The cells of the endodermis are rich in starch grains and the layer is also referred to as the **starch sheath. Pericycle** is



present on the inner side of the endodermis and above the phloem in the form of semi-lunar patches of sclerenchyma. In between the vascular bundles there are a few layers of radially placed parenchymatous cells, which constitute medullary rays. A large number of **vascular bundles** are arranged in a ring; the 'ring' arrangement of vascular bundles is a characteristic of dicot stem. Each vascular bundle is conjoint, open, and with endarch protoxylem. A large number of rounded, parenchymatous cells with large intercellular spaces which occupy the central portion of the stem constitute the **pith**.

6.2.4 Monocotyledonous Stem

The monocot stem has a sclerenchymatous hypodermis, a large number of scattered vascular bundles, each surrounded by a sclerenchymatous bundle sheath, and a large, conspicuous parenchymatous ground tissue (Figure 6.4 b). Vascular bundles are conjoint and closed. Peripheral vascular bundles are generally smaller than the centrally located ones. The phloem parenchyma is absent, and water-containing cavities are present within the vascular bundles.



Monocot stem

① – outer – Epidermis – Parenchyma ✓

② Cortex, Pith, Endodermis, Medullary Rays Absent ✓

③ hypodermis – Sclerenchyma ✓

④ Ground tissue – Parenchyma ✓

⑤ Vascular Bundle → Scattered ✓
→ large in centre, Small – periphery

– Conjoint, Close (No Cambium) ✓

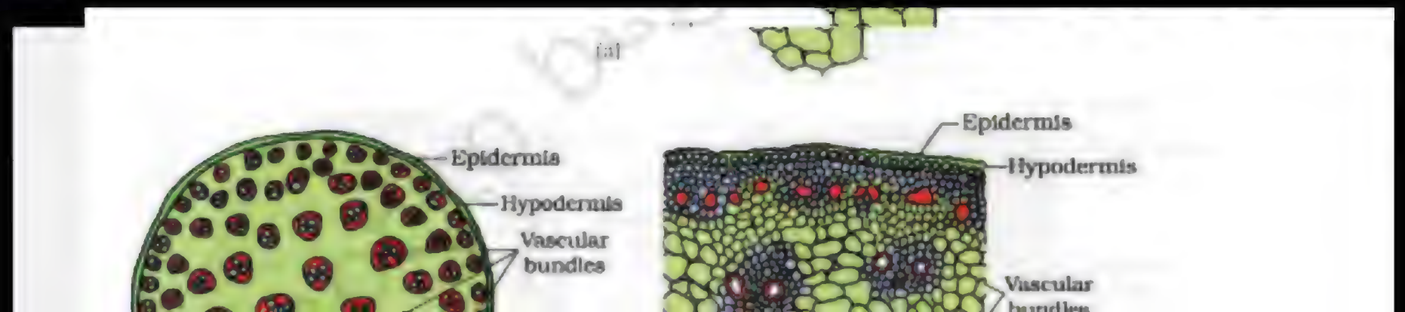
– Bundle sheath cell – Around Vascular Bundle
(made up of Sclerenchyma)

note – Phloem Parenchyma Absent In Monocot

note – Xylem have water Filled cavities

P·P

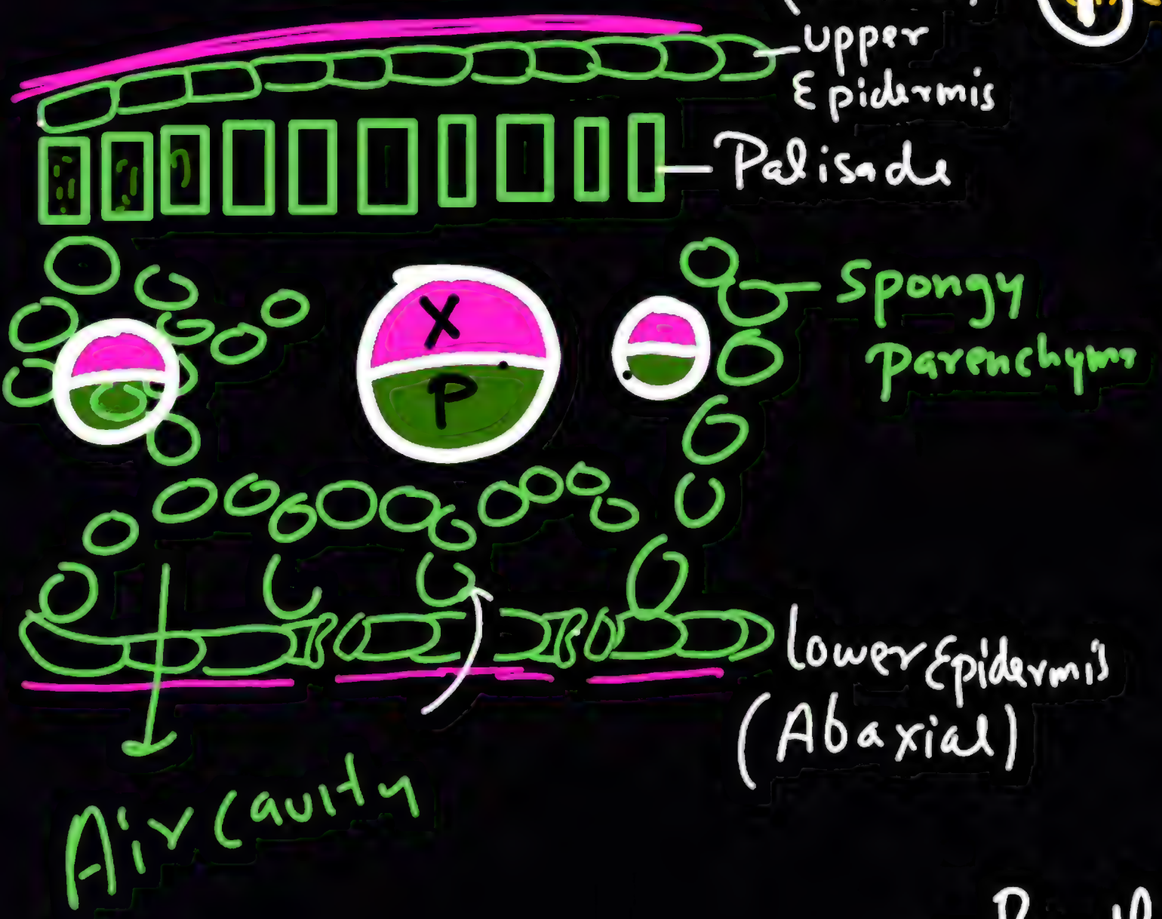
P·X



Dicot Stem	Monocot Stem
Hypodermis → Collenchyma	— Sclerenchyma
Cortical cell, Endodermis, Pericycle → Present	→ Absent
Bundle sheath cell → Absent	→ Present (s)
Vascular Bundle → Equal size	Unequal size
→ In Ring	— Scattered
→ Open conjoint	→ Conjoint Close
Water filled Cavity — Absent	— Present

Dicot leaf – Dorsiventral leaf

(Vertical Section)



→ Vascular Bundle – mid rib and veins

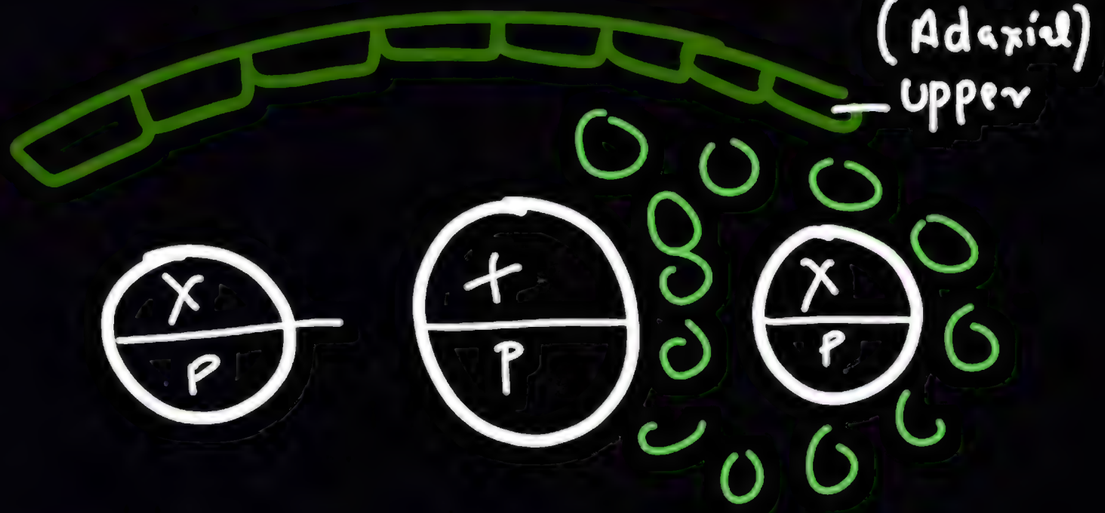
Leaf structure – Three part

(1) Epidermis – Single layer, Cuticle (thick) present
Upper Epidermis – less stomata / Absent
(Adaxial)
Lower Epidermis (Abaxial) → Large no. of stomata

(2) Ground tissue → Mesophyll cell (Photosynthetic cell)
Two type (a) Palisade – Close to upper Epidermis, parallel arrang
(b) Spongy parenchyma – Intercellular Space present

(3) Vascular Bundle – conjoint, Close
Xylem – towards upper Epidermis
Unequal size V.B → Large Bundle – Mid rib
– Bundle sheath cell Also present

Monocot Leaf — Isobilateral



① — Both layer upper & lower
Same no. of Stomata

② Ground tissue — no differentiation of Palisade & Spongy (Mesophyll cells)

③ Vascular Bundle — Except mid rib
Same size

In Grasses — Upper Epidermis — Bulliform cells
Colourless, when turgid → Leaf exposed
when Flaccid — Leaf curl
] Grasses

Dicot leaf

→ Dorsiventral leaf
→ Stomata more on lower Surface

→ Spongy and palisade Parenchyma → Mesophyll cell Differentiate into

→ Bulliform cells Absent

→ V.B → Unequal size

Monocot leaf

→ Isobilateral leaf
Both Surface have Equal stomata

no Such Differentiation

– Bulliform cells present in Dicot

– V.B – Equal size

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Biomolecule

lecture -01

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Topics

- Amino Acid
  - Proteins
  - Enzymes
- Carbohydrate
- Lipids
- Nucleic Acid

→

Basics

- Primary and Secondary metabolite
  - Acid soluble pool
  - Acid Insoluble pool

no. of Question – Bio

11 – 5 + 2 = 6 – 7

Today's Goal

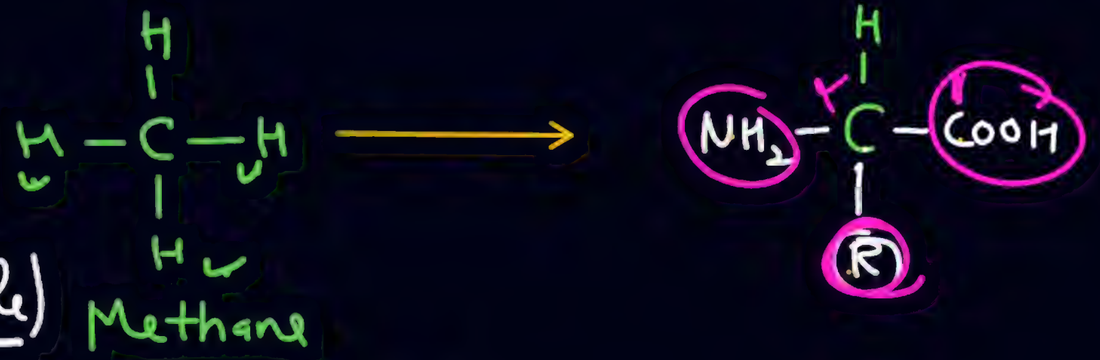
Amino Acids

Amino Acids

Basic structure

- It is a Substituted Methane

→ Hydrogen is Replaced By → COOH, NH_2, R(Variable)



- Amino Acids which are part of protein → α- Amino Acid

Q In Amino Acids Mark incorrect

(a) NH_2 Groups present

(b) COOH Group Present

(c) all Four Hydrogen is Substituted

(d) three H of methane is Substituted

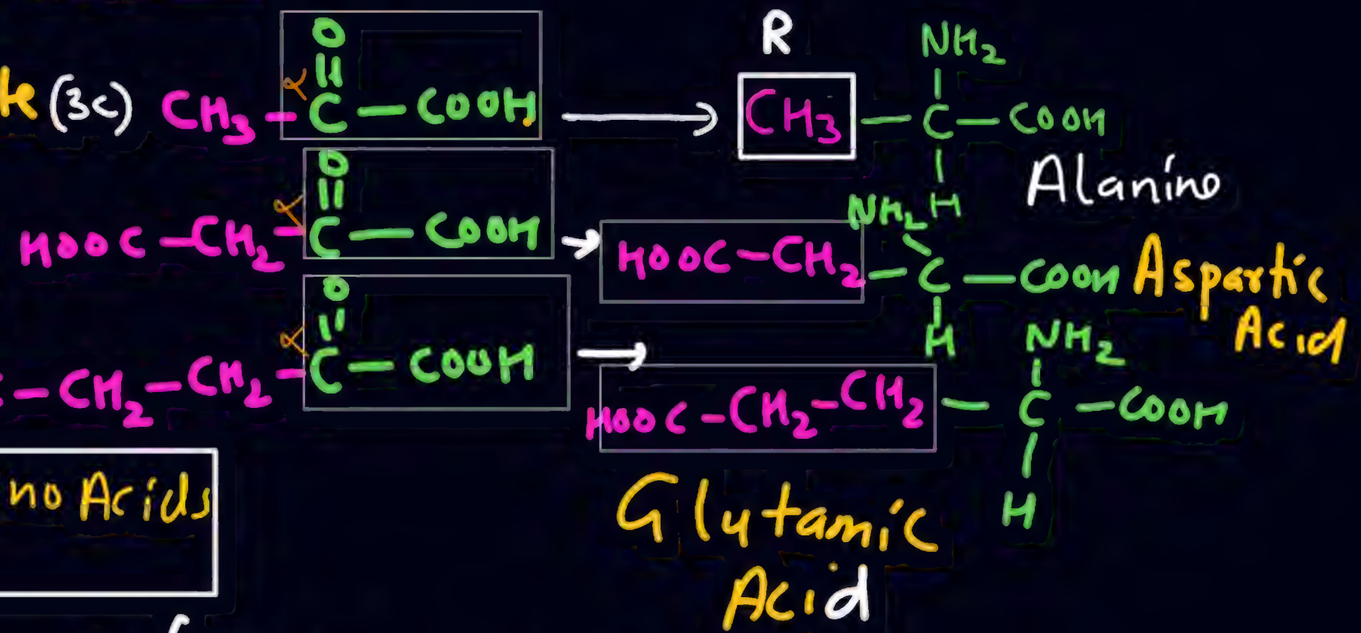
Some Basic Features of Amino Acid

(a) naturally occuring Amino Acids are – α-Amino Acids

α-Keto Acids

- Pyruvate (3c) $CH_3-C(=O)-COOH$
- OAA (4c) $HOOC-CH_2-C(=O)-COOH$
- α-Ketoglutarate $HOOC-CH_2-CH_2-C(=O)-COOH$

Cell (α-Keto Acids $\xrightarrow[\text{Amination}]{}$ α- Amino Acids)

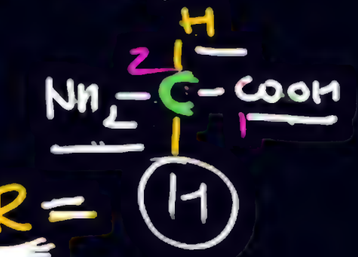


(b) Amino Acids → low molecular wt. (less than 800 dalton)

(c) Amino Acid optically Active
(mostly (aevorotatory)

Glycine → R = H

(optically inactive)



(d) Amino Acid come in Acid soluble pool

(e) Amino Acid in solution can Form Zwitter ion | Amphoteric ion

Q Minimum no. of carbon in Amino Acid

~~(a)~~ two (b) three (c) Four (d) one

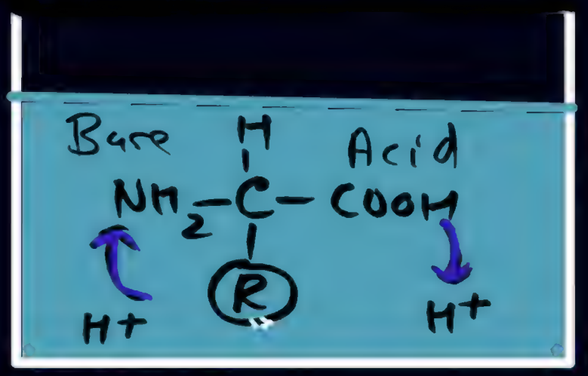
Q Lowest M.W / Simplest Amino Acid

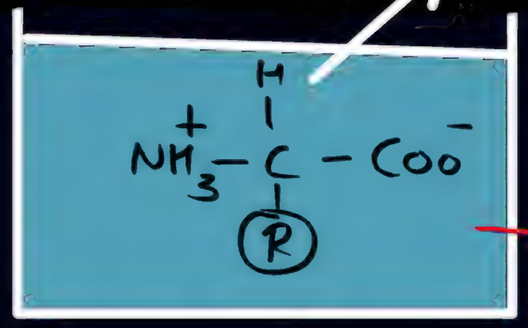
① Alanine ~~(b)~~ Glycine

③ Serine (d) Glutamic Acid

Zwitterion or Amphoteric ion

+ − Both plus and minus charge





Zwitter ion – Both charge

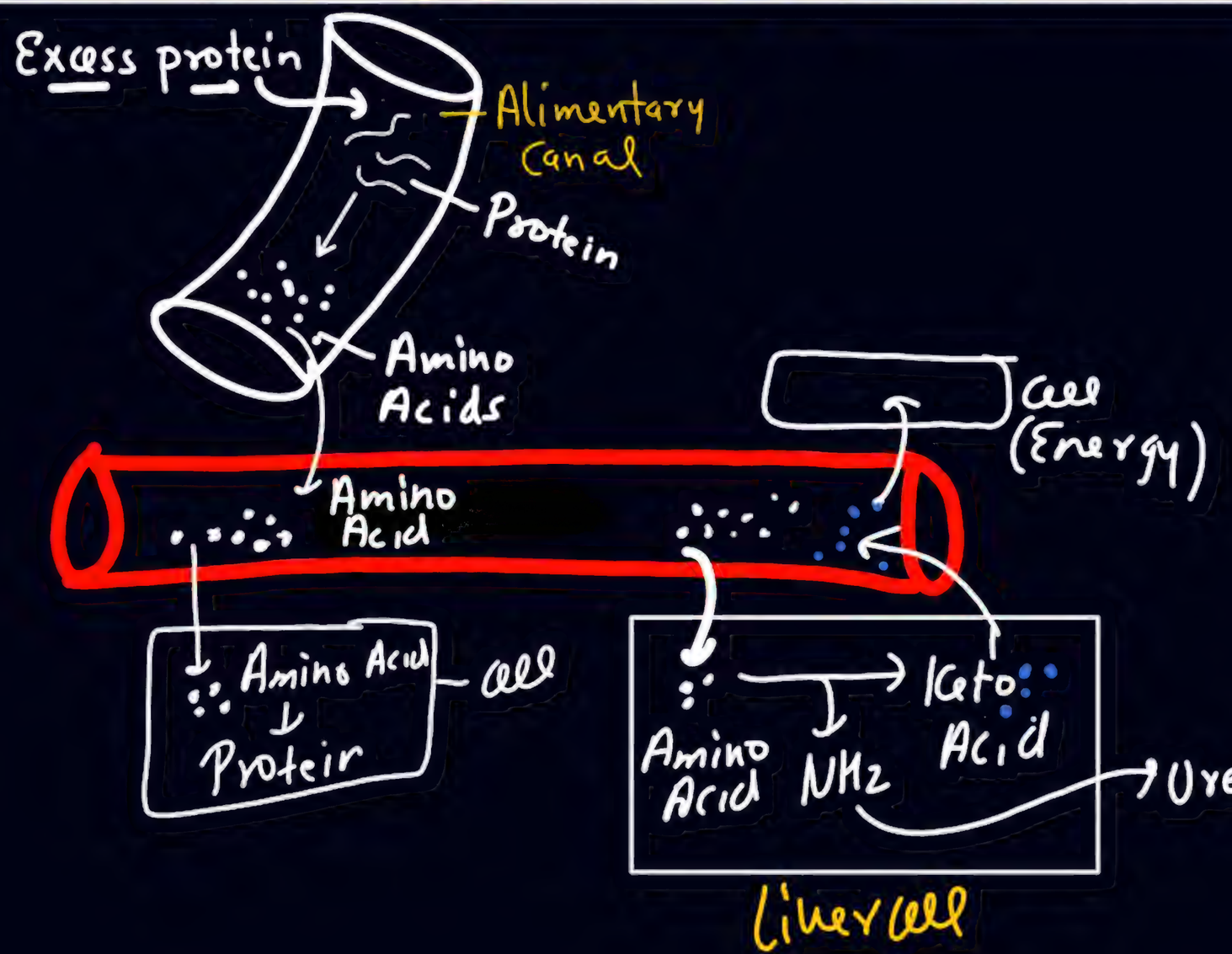
→ PH = 7

$$\left[\begin{array}{l} PIC_1 \\ PIC_2 \\ PI = \dfrac{PIC_1 + PIC_2}{2} \end{array}\right]$$

- Zwitter ion – In solution Amino acid can develop Both Positive and negative charge
- It is not Always – Zwitter ion Form at **PH = 7**
- Since Amino Acid → R-Group Different, Every Amino Acid can Form Zwitter ion at Different PH

Isoelectric PH → PH at which Amino Acid Form Zwitter ion (Isoelectric PH) OR PI

what happens to Excess Amino Acids

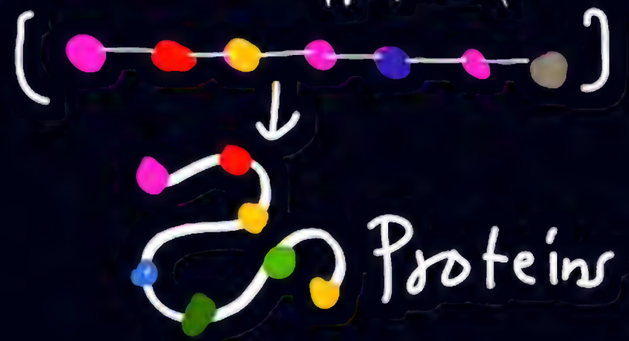


Single → Amino Acid = AA_1

[$AA_1 - AA_2$ – Dipeptide

[$AA_1 - AA_2 - AA_3 - AA_n$]

Polypeptide



Examples of Amino

- Gly – Glycine (R=H)
- Ala – Alanine ($R=CH_3$)
- Val – Valine
- Leu – leucine
- Ileu – Isoleucine
- Phe – Phenylalanine
- Tyr – Tyrosine
- Trp – Tryptophan
- Ser – Serine ($R=CH_2-OH$)

Asp – Aspartic Acid
Glu – Glutamic Acid
Asn – Aspargine
Gln – Glutamine
His – Histidine
Lys – Lysine
Arg – Arginine
} Histones

Met – Methionine
Cys – cystiene
} S- containing

Pro – Proline
Thr – Threonine

standard and non standard Amino Acid

Classification of Amino Acids

Essential and nun Essential

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Biomolecule

lecture - 02

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Topics

Classification of amino acids

proteins

1. Gly - Glycine ✓
2. Ala - Alanine ✓
3. Val - Valine ✓
4. Leu - Leucine ✓
5. Ileu - Isoleucine ✓
6. Phe - Phenylalanine ✓
7. His - Histidine ✓
8. Lys - Lysine ✓
9. Arg - Arginine ✓
10 Pro - Proline ✓

11 Asp - Aspartic Acid ✓
12 Glu - Glutamic Acid ✓
13 Asn - Aspargine ✓
14 Gln - Glutamine ✓
15 Tyr - Tyrosine ✓
16 Thr - Threonine ✓
17 Ser - Serine ✓
18 Meth - Methionine ✓
19 Cys - Cystiene ✓
20 Trp - Tryptophan ✓

Q Which Biomolecule which can Form Zwitter ion

(a) Glucose] Sugar
(b) DiHAP]

(c) Threonine ← N.B
(a) Adenine] N.B

I

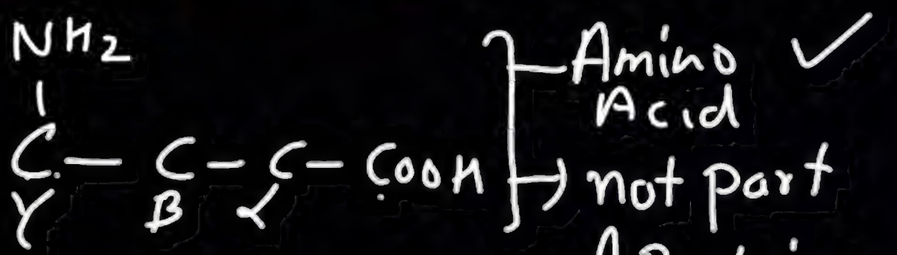
Classification of Amino Acid

Total Amino Acid – 200 Approx
20 – Standard

(a) **Standard Amino Acid** – Part of proteins in plants, Animals, & microbe
→ 20 Amino Acids are standard Amino Acids

(b) Non-standard Amino Acid → Amino Acids But not part of Proteins

Ex → Citrulline
→ Ornithine
→ GABA (Gama amino butyric Acid)



Q Standard Amino Acid – Mark not true
(a) α-Amino Acid (b) M.W low
(c) Amino Group present Other than Alpha carbon
(d) Part of protein

Classification of amino acids on the basis of Essentiality

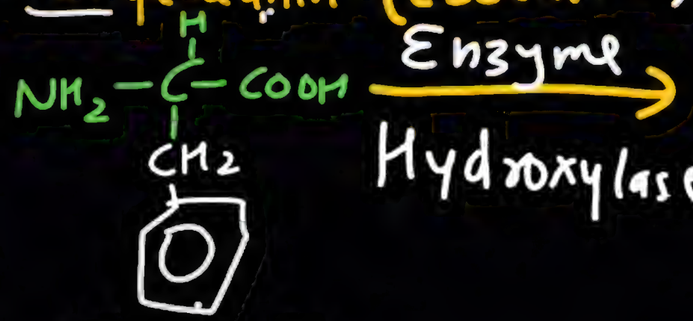
- Essential
- Non-Essential

- All 20 standard Amino Acid - Require in Body (Cells)
- Those Amino Acid which we can synthesise - not Require in Diet outside
- non Essential Amino Acid can be synthesis in Body

→ non-Essential

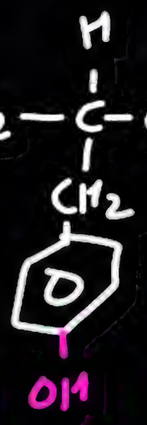
Example

Phenylalanine (Essential)



Essential

Tyrosine (non-Essential)



Plants → all Amino Acid are non-Essential

~~S-I~~ Phenylalanine & Tyrosine Both can be taken in Diet

~~S-II~~ - Tyrosine not Require in Diet But Require in Body

Body → Essential Require + non-Essential

Essential Amino Acid

Require in Diet
Require in Body

Ex- Ar Va H I L L M P T T

Ar → Arginine
Va → Valine
H → Histidine
I → Isoleucine
L → Lysine
L → Leucine
M → Methionine
P → Phenylalanine
T → Threonine
T → Tryptophan

= 10 Essential

Animals → 7 Essential
Humans → 8 Essential + 2 (Histidine, Arginine) → Slow synthesis (Semi-Essential)

HAT → Histidine, Arginine, Threonine → non-Essentials

Note
Threonine is non-Essential But Essential For Human

Non Essential

- not Require in Diet
- Require in Body

Glycine, Alanine, Tyrosine,

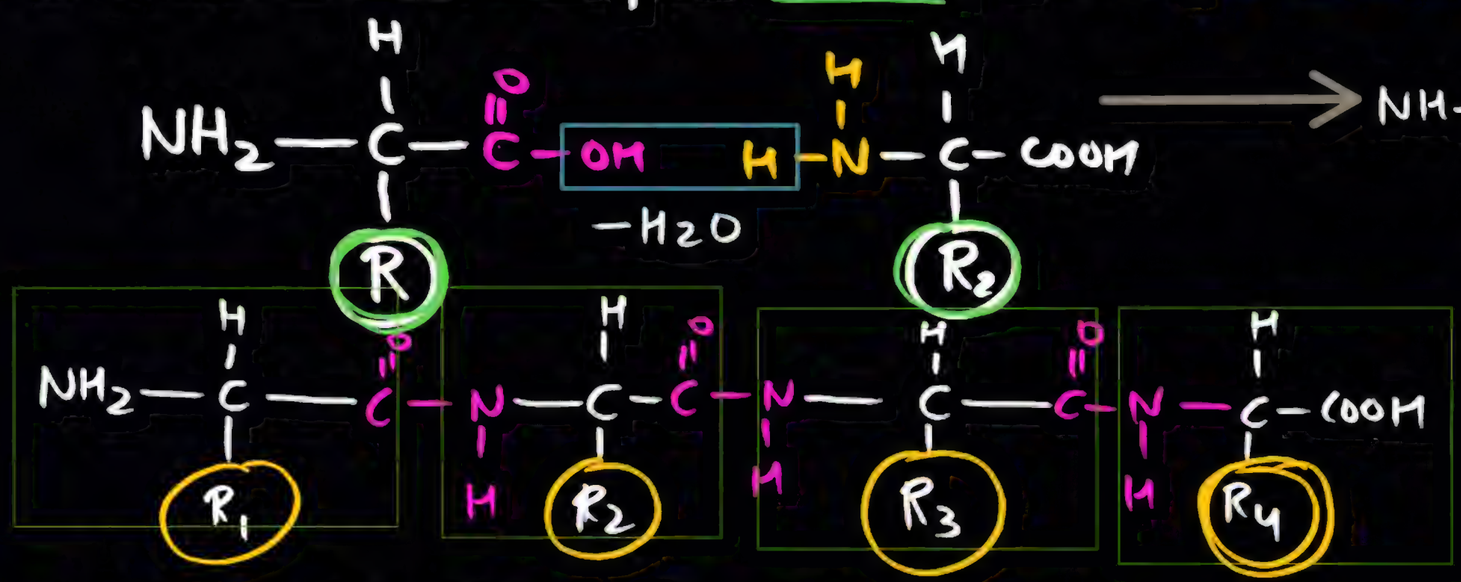
20 minus Essential = non-Essential

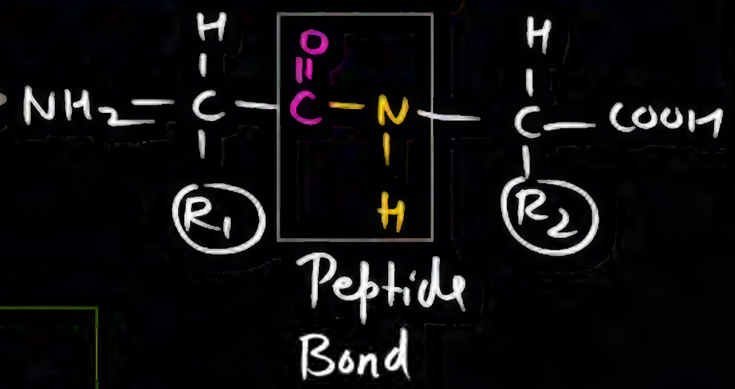
Q Essential Amino Acid
(a) Glycine (b) Leucine (c) Alaline (d) Serine

Q Non-Essential
(a) Methionine (b) Lysine
(c) Tyrosine (d) valine

Classification of amino acids on the basis of – R-Group chemical nature

– Amino Acids → R-Group is variable & Free (not involve in Bond) in proteins





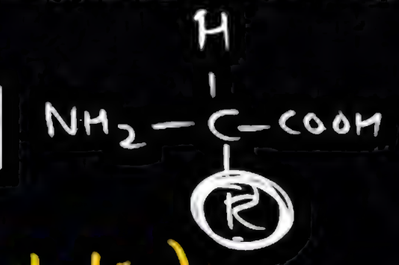
[Two Amino Acid (one peptide Bond)]

– Chemical & Physical properties depend on – NH_2, COOH & R-Group

– But on the Basis of chemical nature → Amino Acids can be of R-Group Non-polar & Polar

Classification of Amino Acid

Non polar Amino Acid



R Group - Hydrocarbon Chain → Hydrophobic)

(not Soluble in water)

GAVLI P

$R = CH_3$ (Alanine) ☆

$R = CH(CH_3)(CH_3)$ valine

$R = CH_2-CH(CH_3)-CH_3$ leucine

$R = CH(CH_3)-CH_2-CH_3$ Isoleucine

$R = CH_2-C_6H_5$ - Phenyalanine

polar Amino Acid

R Group Hydrophillic, Soluble in water)

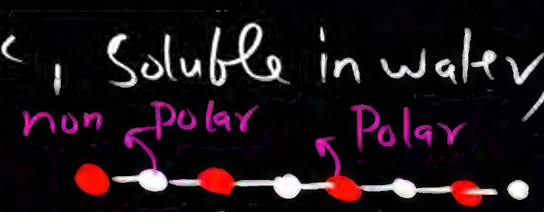
Example:-

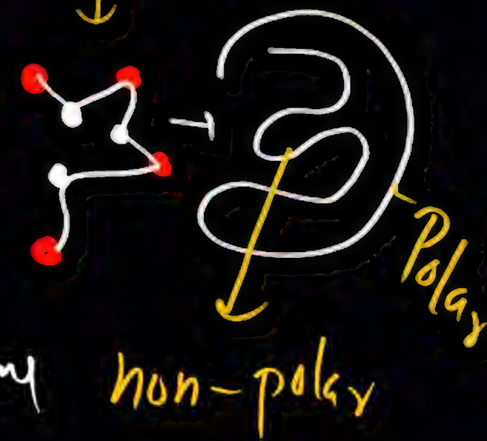
$R = CH_2-OH$ - Serine

$R = CH(OH)-CH_3$ - Threonine

$R = CH_2-COOH$ - Aspartic Acid

$R = CH_2-SH$ (Cysteine)





Q Which A.A present on Surface of Enzyme

(a) Alanine (b) leucine (c) Serine

(d) Isoleucine

Polar Amino Acids — R-Group Hydrophilic, water soluble

(a) OH Group Containing → (T, T, S)

- $R = -CH_2-OH$ — Serine
- $R = -CH(OH)-CH_3$ — Threonine
- $R = CH_2-C_6H_4-OH$ — Tyrosine (Tyrosine)

Tyrosine
Threonine
Serine

Q Difference in Glutamic Acid & Glutamine
(a) no. of Carbon
(b) Presence of COOH Group
(c) no. of N

2. Acidic – Extra COOH Group

$NH_2-\overset{\alpha}{C}H(R)-COOH$

Ex – A – Aspartic Acid → $R = CH_2-COOH$
G – Glutamic Acid → $R = CH_2-CH_2-COOH$

On α-Carbon

3. Amides

(Glutamine / Asparginel)

Aspartic Acid, Glutamic Acid } – COOH Group → React with NH_2 (in R)

$NH_2-CH(R)-COOH$ → Asparagine

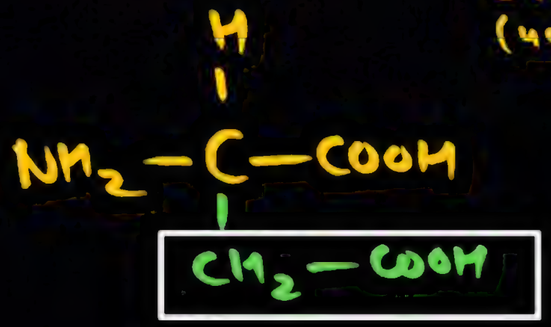
$R = CH_2-COOH$ + React with NH_2 → Asparagine ($NH_2-CH(CH_2-CONH_2)-COOH$)

Aspartic Acid

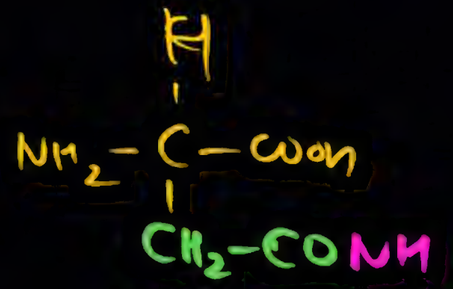
Similarly Glutamic Acid Give Glutamine

OAA can give (4C)

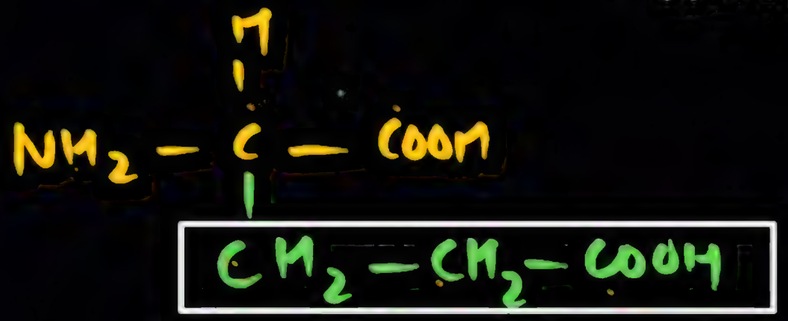
(a) Glutamic (b) ~~Aspartic~~ Aspartic Acid



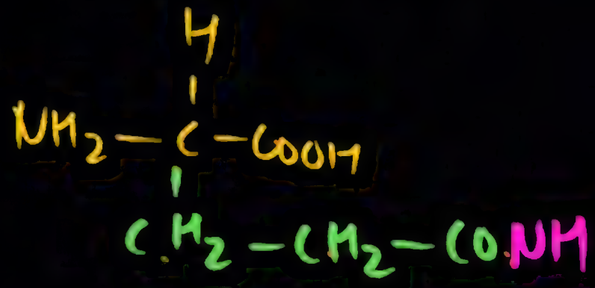
Aspartic Acid



Asparagine 4C



Glutamic Acid



Glutamine 5C

Amides

Q Which is Amide

(a) Histidine (b) Lysine ~~(c)~~ Glutamine (d) all

Three Structure learn

$R = H \longrightarrow$ Glycine

$R = CH_3 \longrightarrow$ Alanine

$R = CH_2 - OH$ – Serine

(4) Basic Amino Acids → Extra NH_2 Present

R – Group – NH_2 Group Present

H – Histidine – 3N

L – lysine – 2N

A – Arginine – 4N

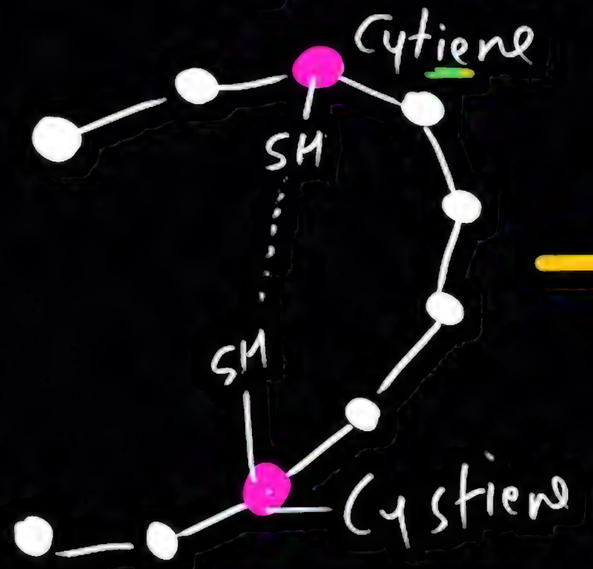
also present in Histone

Q Basic Amino Acid no. of nitrogen
(a) one (b) two (c) two or more (d) none

Q Amino Acid Present only in Protein
(a) Alanine
(b) Cystiene
(c) Cystine
(d) Glycine

(5) S-containing Amino Acid → M – Methionine – R ⇒ $CH_2 - CH_2 - S - CH_3$

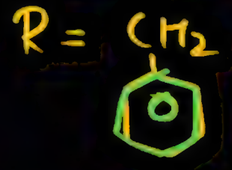
C – Cystiene → R ⇒ $CH_2 - SH$



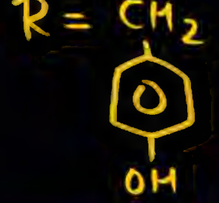
Disulfide Bridge/Bond (Ex- Insuline)

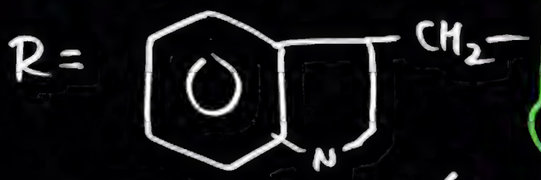
6. Aromatic → Ring Structure (three)

Phenylalanine



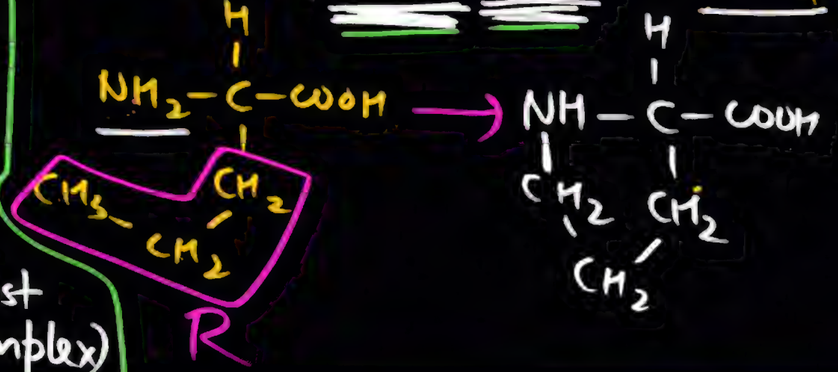
Tyrosine





Tryptophan (most complex)

7. Imino Acid - Proline



(a) Non-polar – GAVLI P]

(b) OH-containing → T TS]

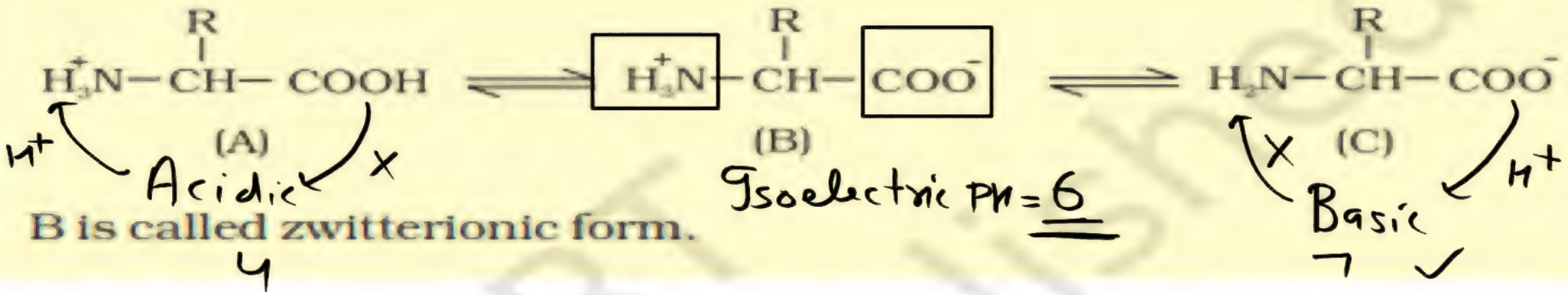
(c) Acidic → Asp, Glu]

(d) Amides → Asn, Gln]

(e) Basic → HLA]

(f) Aromatic → Phe, Tyr, Trp

(g) S-containing → Met, Cys

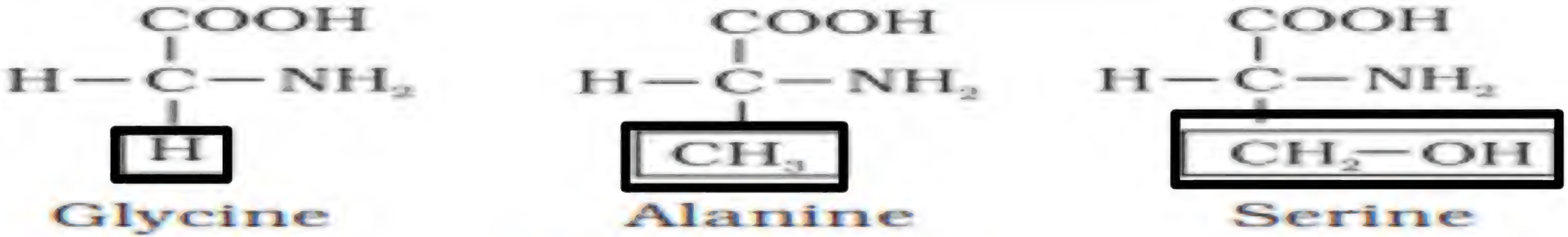


B is called zwitterionic form.

types. The R group in these proteinaceous amino acids could be a hydrogen (the amino acid is called glycine), a methyl group (alanine), hydroxy methyl (serine), etc. Three of the twenty are shown in Figure 9.1.

The chemical and physical properties of amino acids are essentially of the amino, carboxyl and the R functional groups. Based on number of amino and carboxyl groups, there are acidic (e.g., glutamic acid), basic (lysine) and neutral (valine) amino acids. Similarly, there are aromatic amino acids (tyrosine, phenylalanine, tryptophan). A particular property of amino acids is the ionizable nature of $-NH_2$ and –COOH groups. Hence in solutions of different pH, the structure of amino acids changes.

Amino acids are organic compounds containing an amino group and an acidic group as substituents on the same carbon i.e., the α-carbon. Hence, they are called α-amino acids. They are substituted methanes. There are four substituent groups occupying the four valency positions. These are hydrogen, carboxyl group, amino group and a variable group designated as R group. Based on the nature of R group there are many amino acids. However, those which occur in proteins are only of twenty



Amino acids

Extra points of amino acids

Simplest amino acids — Glycine

Most complex amnio acids → Tryptophan (Precursor of Auxin & Serotonin)

Optically inactive amino acids → Glycine

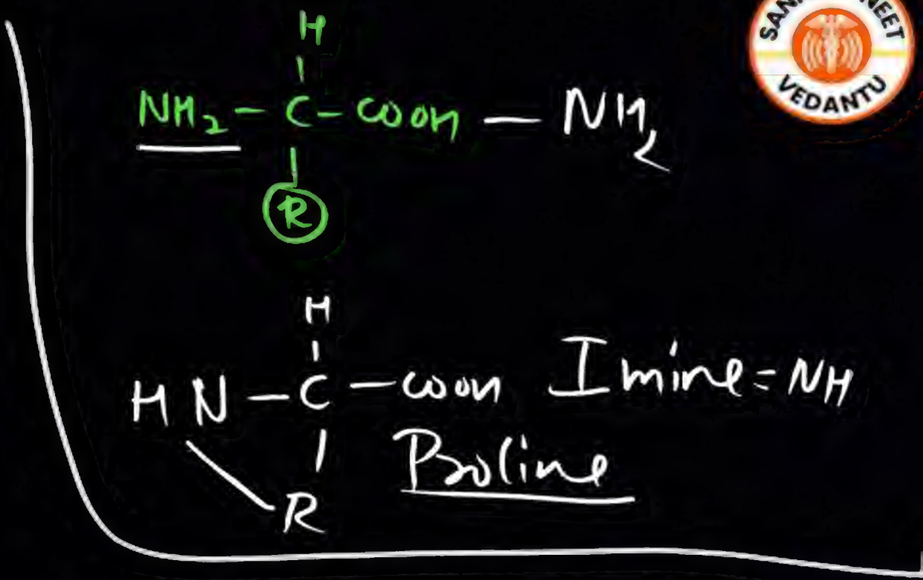
Histamine ⟶ (Histidine minus NH_2)

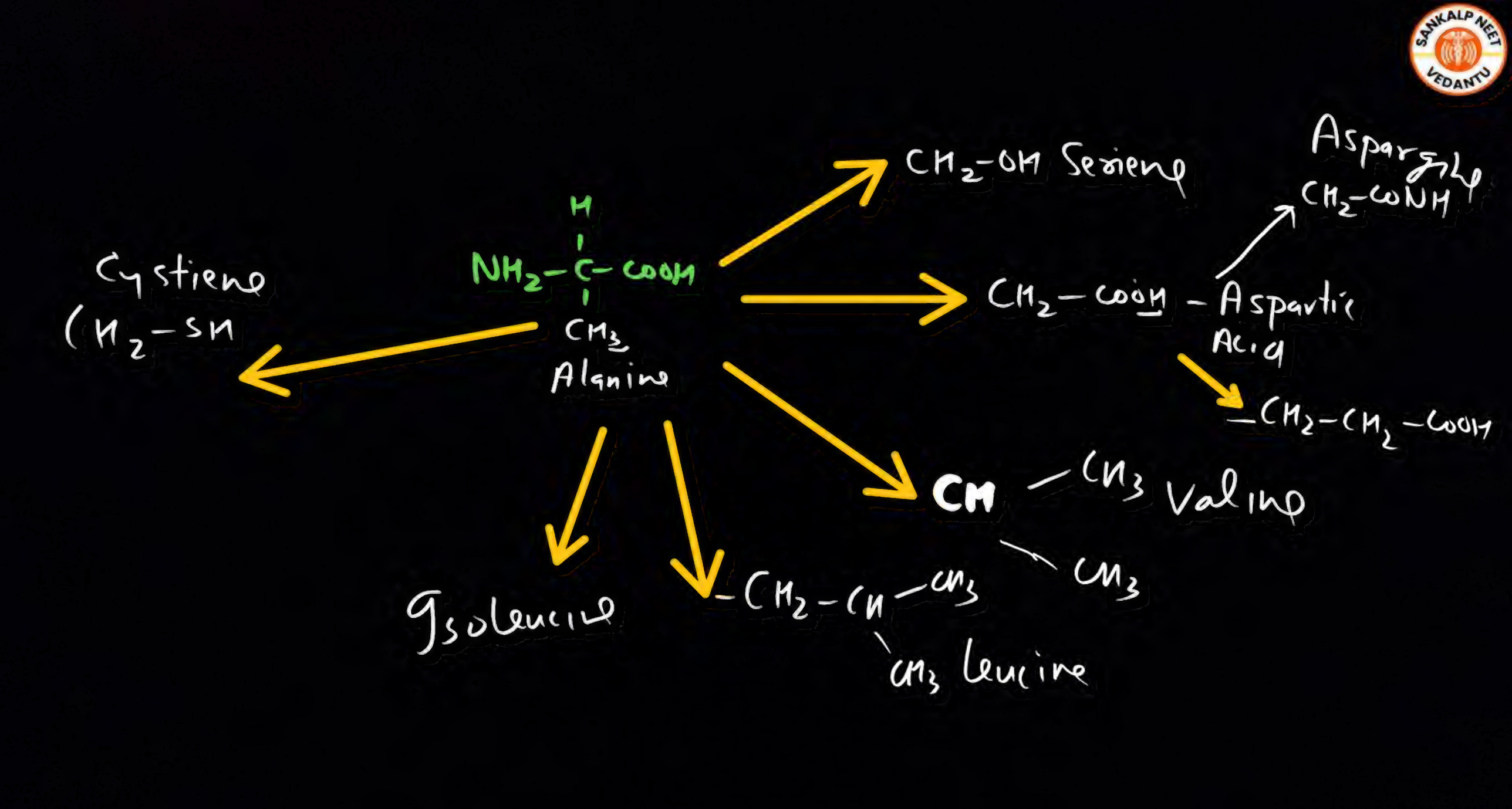
Part of histones → lysine & Arginine

Artitifical sweetener → Aspartame (two Amino Acid)

Amino acid in PKU → Phenylalanine ⊥ not converted into tyrosine → Tyrosine

(Phenyl Ketone Urea)




SANKALP NEET
VEDANTU
CH_2-OH Serine
Asparagine
CH_2-CONH
Cysteine
CH_2-SH
$NH_2-C(H)(CH_3)-COOH$
Alanine
CH_2-COOH - Aspartic Acid
$-CH_2-CH_2-COOH$
$CH(CH_3)_2$ Valine
CH_3
Isoleucine
$-CH_2-CH(CH_3)_2$
CH_3 Leucine

DOPA-01

(a) only S-I correct (b) only S-II correct (c) Both S-I & S-II correct (d) Both wrong

Q1 S-I Lysine is more basic than Histidine
S-II Aspartic Acid more carbon than Glutamic Acid

Q2 S-I At PI Amino Acid found as Zwitter ion
S-II Zwitter ion at Acidic PH have true charge

Q3- S-I Tyrosin & Tryptophan is Aromatic Amino Acid
S-II Glutamin & Asparagine is Amide

Q4- S-I Proline is Amino Acid
S-II Proline is Imino Acid

Q5- S-I Methionine & Tryptophan is S-containing
S-II Tyrosine is Precursor of Auxin

Q6 Essential Amino Acid which is Aromatic
(a) Tyr (b) Phe (c) Ala (d) Gly

Q7 Amino Acid which is neutral
(a) Asp (b) Glu (c) lys (d) Val

Q8 For Disulphide Bridge which Amino Acid is used
(a) Cystiene (b) Alanine (c) Glycine (d) Seriene

Q9 OH Groups Containing A·A are all Except
(a) Tyr (b) Ser (c) threonine (d) Glycine

Q10 Amino Acid is optically inacting
(a) lysine (b) Seriene (c) Phe (d) none

Q1 Amino Acid in protein not have feature

(a) ASP (b) low M.W (c) Dextro rotatory (d) α - Amino Acid

Q2 R = H present in ____ Amino Acid

(a) Glycine (b) Alanine (c) Tyrosine (d) Serine

Q3 Non - Essential Amino Acid is

(a) Valine (b) Leucine (c) Isoleucine (d) tyrosine

Q4 Citrulline have feature Except

(a) ASP (b) Amino Acid (c) Part of protein (d) Biomolecule

Q5 Percentage of Carbohydrate is greater than in cell

(a) Protein (b) Nucleic Acid (c) lipid (d) water

Q6 Amino Acid which are non-Essential
(a) Leucine (b) Tryptophan (c) Proline (d) Isoleucine

Q7
S-I – Plants have all Amino Acid Essential
S-II – Animals have some Amino Acid Essential

(a) S-I correct (b) S-II Correct (c) Both S-I & S-II correct (d) Both wrong

Q8 Optically inactive Amino Acid is
(a) Glycine (b) Serine (c) Lysine (d) Arginine

Q9 Present in ASP & are optically Active
(a) Serine (b) Cellulose (c) Starch (d) DNA

Q10 OH Group present in Amino Acid
(a) Serine (b) Phenylalanine (c) Alanine (d) all

MANTHAN NEET 2025 - 1.0 & 2.0

SANKALP NEET VEDANTU

Biomolecule

lecture - 03

Botany

TARUN SIR

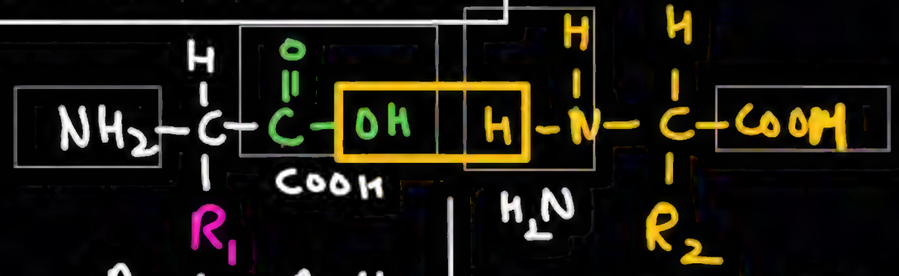
Topics

Classification of amino acids

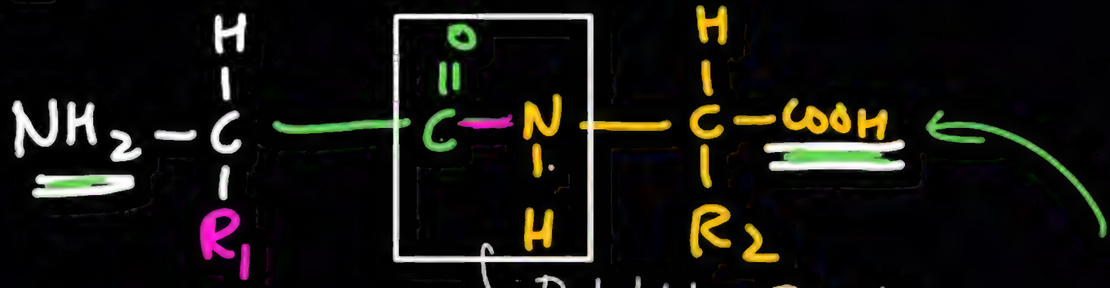
proteins

Bonds Between Amino Acids

- Two Amino Acid link → By peptide Bond
- COOH group of First Amino Acid
  React with NH_2 of second Amino Acid
  (loss of water occur)
- Compound name = Dipeptide
  (two Amino Acid
  one peptide Bond)



$-H_2O$



$NH_2 - AA_1 — AA_2$

Dipeptide

what is polypeptide chains

→ Chain of Amino Acid – Polypeptide chain

$NH_2 - AA_1 - AA_2 - AA_3 - \cdots - AA_n - COOH$

(N-Terminal) (C-terminal)

→ Each polypeptide

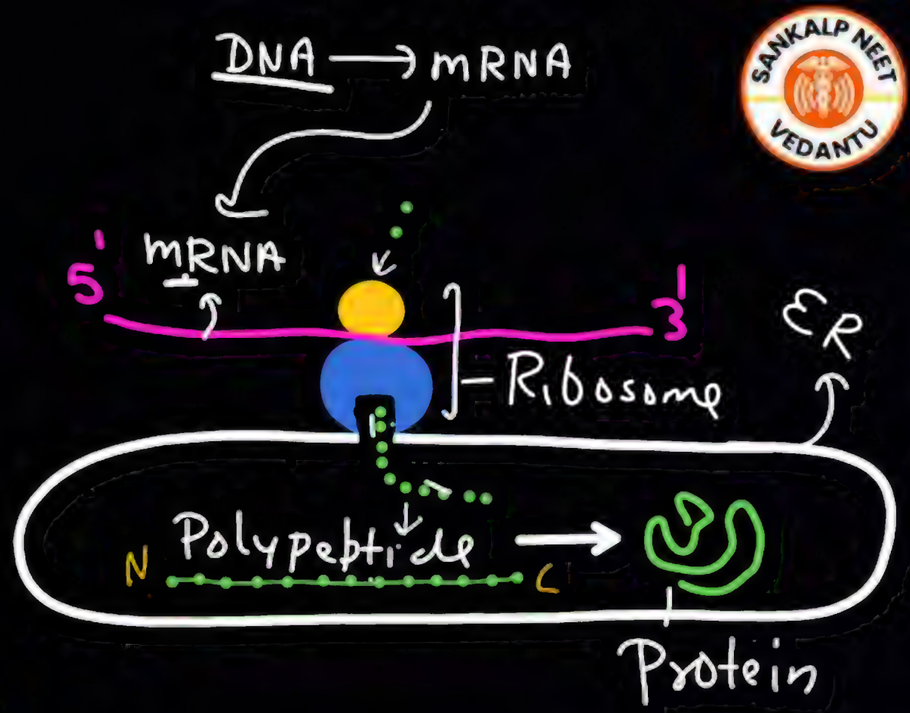
Chain ⟶ ① n-Amino Acid, peptide Bond → n-1

② one end → NH_2 present – N-Terminal

another end → COOH Group present → C-terminal

③ Sequence of Amino Acid Decided By – DNA

④ Folded & Functional Form of Polypeptide chain – Protein



Proteins

→ Heteropolymer of Amino Acids

→ Folded polypeptide chain Form protein

→ Protein come – Acid insoluble pool

→ Ribosome involve in protein synthesis

→ Bond present in protein – Peptide

Difference in polypeptide & Protein Chain

H_2N ——— COOH

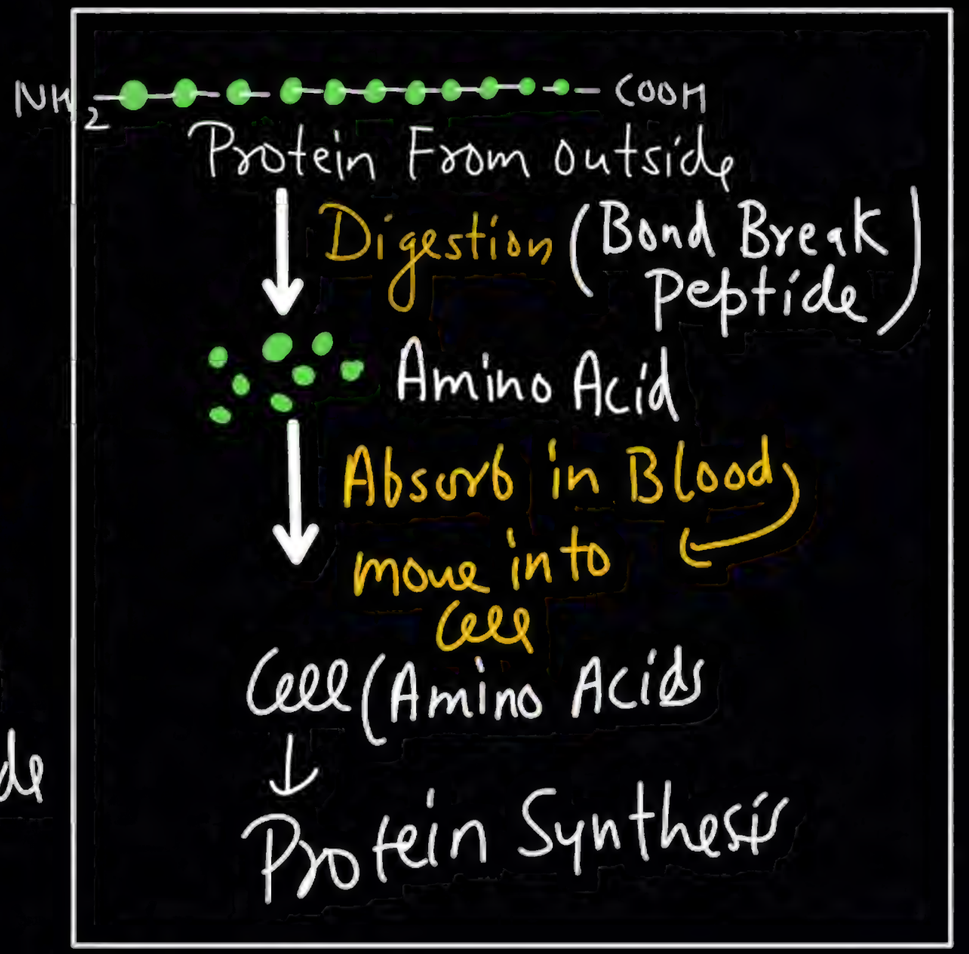
Polypeptide chain

→ (Protein)

NH_2

HOOC

Folded and Functional Form of polypeptide Chain



Level of strcture

Classification of Protein on the Basis of level of structure

(a) Primary structure (1° structure)

NH_2 — ●●●●●●●●● — COOH

Polypeptide chain = Primary structure

→ One side N-terminal, Another side C-terminal

→ Bond → Peptide

→ Sequence → decided By DNA

→ If Primary structure Functional = Protein

Ex- Growth Hormone

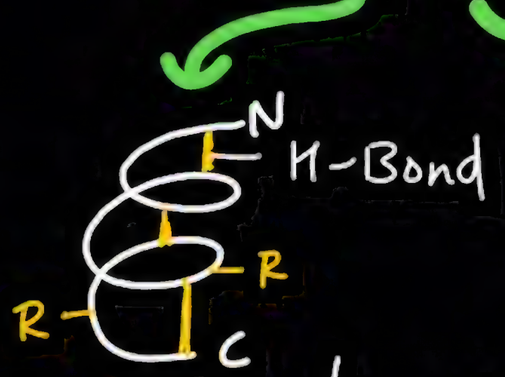
(b) Secondary structure (2° structure)

DNA → mRNA

↓ Ribosome

N — C

1° structure

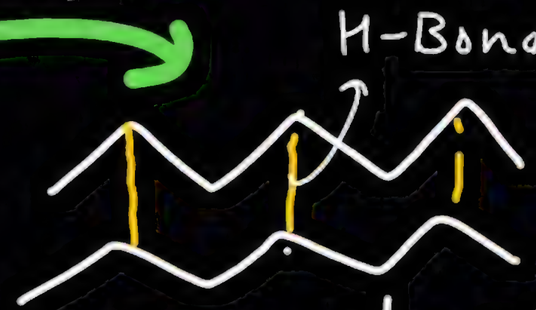


2° structure / α-helix

(Bond → peptide, H-Bond)

- Right handed coil

Ex- α-Keratin

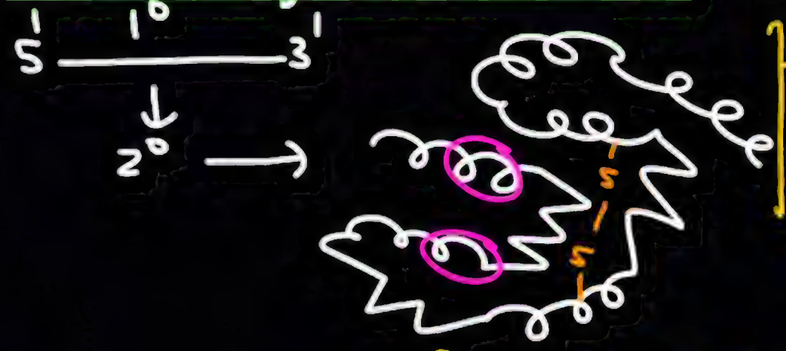


B-sheet / B-Pleated

- Bond - Peptide
- H-Bond
- Sheet like structure

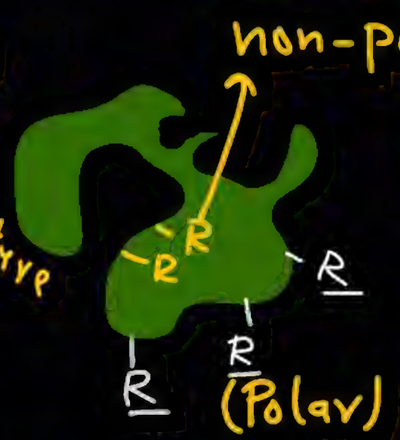
Ex- Silk protein

Tertiary structure



3° structure

Hollow wool like structure



Bond → Peptide, H-Bond, Disulfhide Bridge (By cystiene)

ionic interaction By Amino Acid (Polar), Hydrophobic Bond (non-polar Amino Acid)

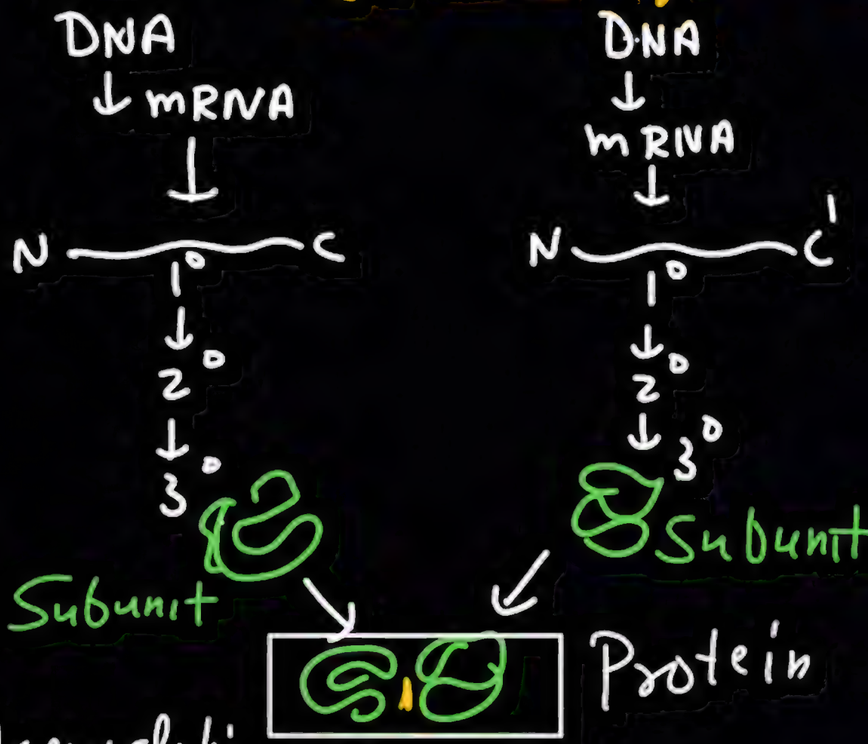
Vanderwall

Ex – Enzymes, Antibodies, Myoglobin

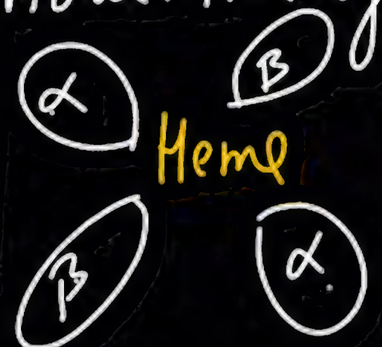
Note → tertiary structure Require for Biological Activity

Quatenavy

(4° structure)



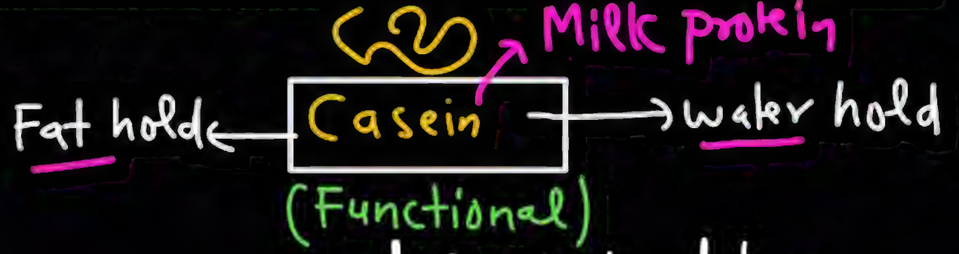
Adult Haemoglobin



(two α-Subunit two β-Subunit)

Denaturation of proteins

Milk – Emulsion →
(Mix two Form which is immisible)



Acid, temp inc.

Protein Casein Denature
(Shape change → Function loss [Fat, water seperate]

Q Which structure not Destroyed During Denaturation

~~(a) 1°~~ (b) 2° (c) 3° (d) all

Denaturation → Protein Function → depend on shape come after Folding
→ Shape can get change By change in PH & temp.
→ During Denaturation → Bond Break (Disulphide, ionic, vandel wall H-Bond)
Only peptide Bond Not Break)

Classification of proteins

I On the Basis of level of structure (Biology - Protein - 4 level)

(inorganic - Structure mean Formula - $MgCl_2$
organic → 2-D structure
Physics - 3-D structure)

(a) 1° or primary structure

(b) 2° or Secondary structure

(c) 3° or tertiary structure

(d) 4° or Quatenary structure

II On the Basis of shape →

(a) Globular → - 3° or 4° structure

(Water soluble)
Spherical

Ex - Enzymes are Globular Enzyme

(b) Fibrous → Elongated
2° or 1°

Water insoluble
Ex - Actin, Myosin

III on the Basis of Function

Functions of Proteins

(1) Catalyst – Most Enzymes are proteins → Ex - trypsin

(2) Channels – on Membrane – channels – Ex – Glut-4 (Glucose move)

(3) Receptors – Present on Membrane (Eye, nose, Ear)

(4) Blood clotting – Prothrombin, Fibrogen

(5) Antibodies – Fight to Infection → Gamma globulin

(6) Hormones – Ex – Insulin

(7) intercellular matrix – Collagen - B/w cell Fibre Form

(most Abundant protein in Animals)

note – In plants → RUBISCO – Most Abundant protein in plant & On Earth

TABLE 9.5 Some Proteins and their Functions

Protein	Functions
Collagen	Intercellular ground substance
Trypsin	Enzyme
Insulin	Hormone
Antibody	Fights infectious agents
Receptor	Sensory reception (smell, taste, hormone, etc.)
GLUT-4	Enables glucose transport into cells

9.4 Proteins

Proteins are polypeptides. They are linear chains of amino acids linked by peptide bonds as shown in Figure 9.3.

Each protein is a polymer of amino acids. As there are 20 types of amino acids (e.g., alanine, cysteine, proline, tryptophan, lysine, etc.), a protein is a heteropolymer and not a homopolymer. A homopolymer has only one type of monomer repeating 'n' number of times. This information about the amino acid content is important as later in your nutrition lessons, you will learn that certain amino acids are essential for our health and they have to be supplied through our diet. Hence, dietary proteins are the source of essential amino acids. Therefore, amino acids can be essential or non-essential. The latter are those which our body can make, while we get essential amino acids through our diet/food. Proteins carry out many functions in living organisms, some transport nutrients across cell membrane, some fight infectious organisms, some are hormones, some are enzymes.

etc. (Table 9.5). Collagen is the most abundant protein in animal world and Ribulose bisphosphate Carboxylase-Oxygenase (RuBisCO) is the most abundant protein in the whole of the biosphere.

9.7 Structure of Proteins

Proteins, as mentioned earlier, are heteropolymers containing strings of amino acids. Structure of molecules means different things in different contexts. In inorganic chemistry, the structure invariably refers to the molecular formulae (e.g., NaCl, $MgCl_2$, etc.). Organic chemists always write a two dimensional view of the molecules while representing the structure of the molecules (e.g., benzene, naphthalene, etc.). Physicists conjure up the three dimensional views of molecular structures while biologists describe the protein structure at four levels. The sequence of amino acids i.e., the positional information in a protein – which is the first amino acid, which is second, and so on – is called the **primary structure** (Figure 9.3a) of a protein. A protein is imagined as a line, the left end represented by the first amino acid and the right end represented by the last amino

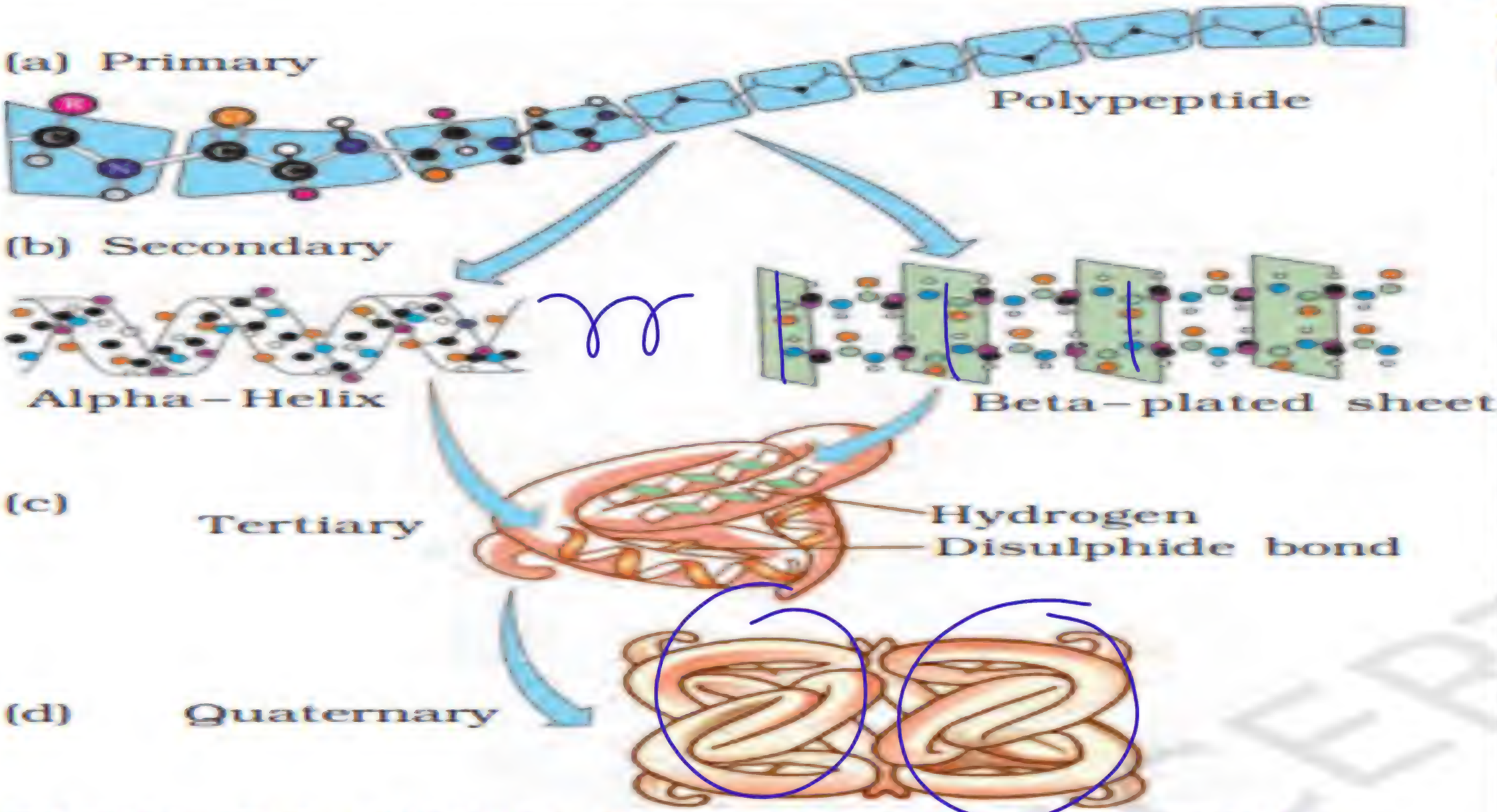
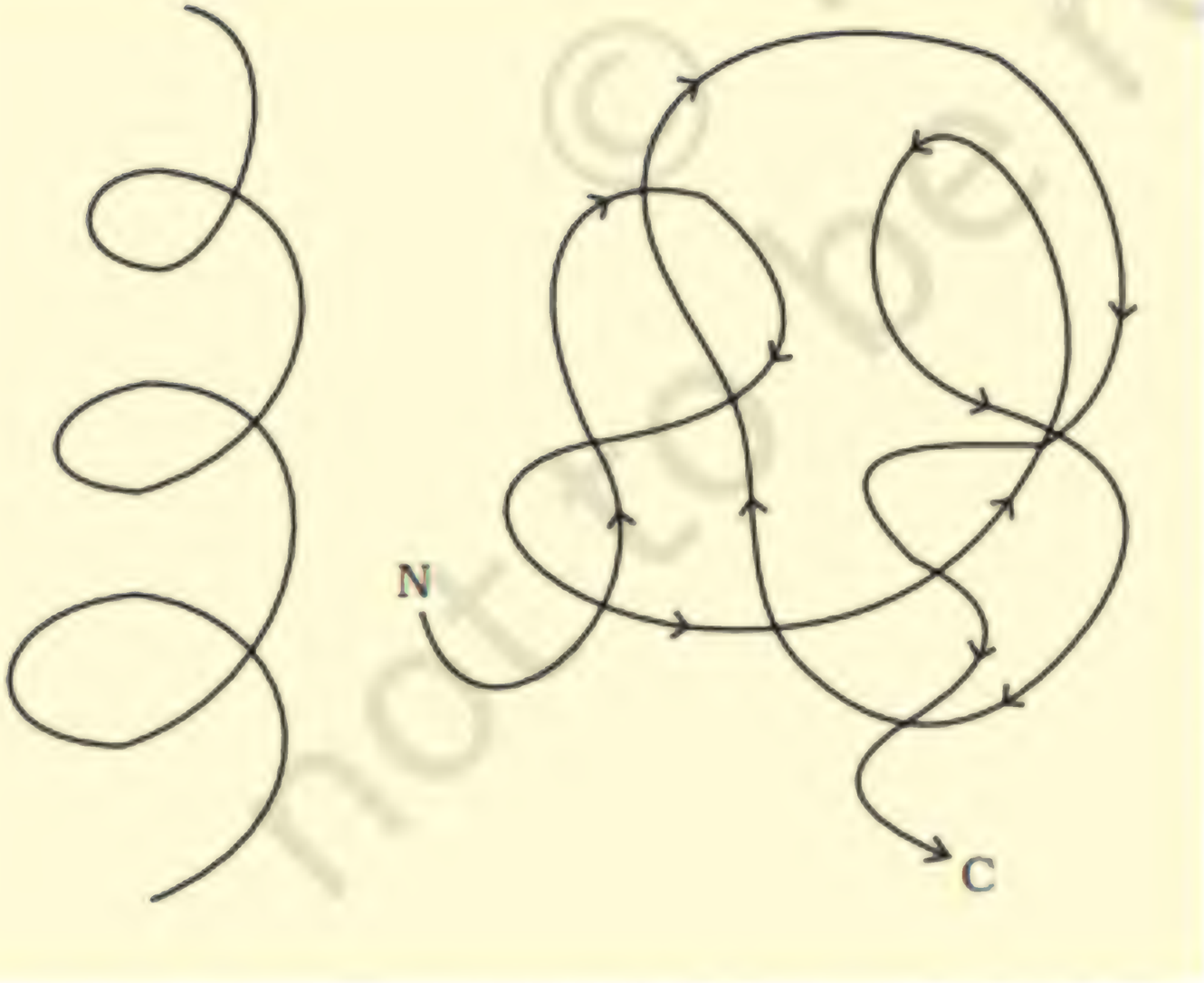


Figure 9.3 Various levels of Protein Structure

secondary structure (Fig. 9.4 b). In addition, the long protein chain is also folded upon itself like a hollow woolen ball, giving rise to the **tertiary structure** (Figure 9.4 c). This gives us a 3 dimensional view of a protein. Tertiary structure is absolutely necessary for the many biological activities of proteins.

Some proteins are an assembly of more than one polypeptide or subunits. The manner in which these individual folded polypeptides or subunits are arranged with respect to each other (e.g. linear string of spheres, spheres arranged one upon each other in the form of a cube or plate etc.) is the architecture of a protein otherwise called the **quaternary structure** of a protein (Fig. 9.4 d). Adult human haemoglobin consists of 4 subunits. Two of these are identical to each other. Hence, two subunits of α type and two subunits of β type together constitute the human haemoglobin (Hb).


N
C

DOPA

Q1 Bond present in 1° structure

(a) peptide (b) H-Bond (c) ionic (d) all

Q2 In chain of 50 Amino Acid no. of peptide Bond

(a) 10 (b) 25 (c) 49 (d) all

Q3 In Quatenary structure with ten 3° structure number of polypeptide chain

(a) 10 (b) 5 (c) 11 (d) 9

Q4 Which is not tertiary Structure

(a) Enzyme (b) Haemoglobin (c) Myoglobin (d) all

Q5 Hollow wool structure

(a) 1° (2) 2° (c) 3° (d) all

Q6 S-I Peptide Bond Form inside cell
S-II 2° structure not have peptide Bond

Q7 S-I In Same protein Both 1° & 2° structure present
S-II In same protein Both 1° & 2° Functional

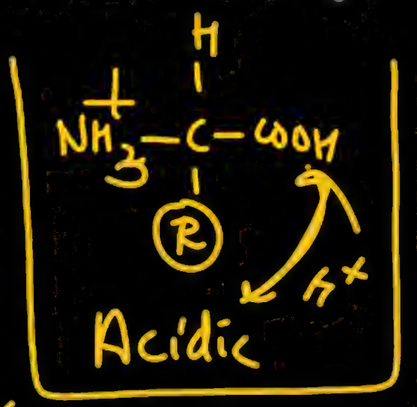
Q8 S-I H-Bond present in 2° and 3° structure
S-II Proteins are mostly left handed helix

Q9 S-I Polypeptide chain can be protein
S-II Polypeptide chain is 1° structure

Q10 S-I H-Bond not Break during denaturation
S-II H-Bund Break during protein Folding

DOPA-03

(a) only S-I correct (b) only S-II correct (c) Both S-I & S-II correct (d) Both wrong



Q1 S-I lysine is more basic than Histidine ✗

S-II Aspartic Acid more carbon than Glutamic Acid (5c) ✗ (4c)

Q2 S-I At PI Amino Acid found as Zwitter ion ✓

S-II Zwitter ion at Acidic PH have (two) charge ✗

Q3 S-I Tyrosin & Tryptophan is Aromatic Amino Acid ✓

S-II Glutamin & Aspargine is Amide ✓

Q4 S-I Proline is Amino Acid ✓

S-II Proline is Imino Acid ✓ NH

Q5 S-I Methionine & Tryptophan is S-containing ✗

S-II Tyrosine is Precursor of Auxin ✗

Q6 Essential Amino Acid which is Aromatic

(a) Tyr (b) Phe (c) Ala (d) Gly

Ar Va H I L L M P T T

Phe

Q7 Amino Acid which is neutral

(a) Asp (b) Glu (c) lys (d) Val

Q8 For Disulphide Bridge which Amino Acid is used

(a) Cystiene (b) Alanine (c) Glycine (d) Seriene

Q9 OH Groups Containing A·A are all Except

(a) Tyr (b) Ser (c) threonine (d) Glycine

Q10 Amino Acid is optically inacting

(a) lysine (b) Seriene (c) Phe (d) none

Q1 Amino Acid in protein not have feature

(a) ASP (b) low M.W (c) Dextro rotatory (d) α-Amino Acid

Q2 R = H present in —— Amino Acid

(a) Glycine (b) Alanine (c) Tyrosine (d) Serine

Q3 Non-Essential Amino Acid is

Phe (Ess) ⟶ tyr (Non Es

(a) Valine (b) Leucine (c) Isoleucine (d) tyrosine

Q4 Citrulline have feature Except

(a) ASP (b) Amino Acid (c) Part of protein (d) Biomolecule

Q5 Percentage of Carbohydrate is greater than in cell

(a) Protein (b) Nucleic Acid (c) lipid (d) water

Q6 Amino Acid which are non-Essential
(a) Leucine (b) Tryptophan (c) Proline (d) Isoleucine

Ar Va HILL MPTT

Q7
S-I – Plants have all Amino Acid Essential ✗
S-II – Animals have some Amino Acid Essential ✓

(a) S-I correct (b) S-II correct (c) Both S-I & S-II correct (d) Both wrong

Q8 Optically inactive Amino Acid is
(a) Glycine (b) Serine (c) Lysine (d) Arginine

Q9 Present in ASP & are optically Active
(a) Serine (b) Cellulose (c) Starch (d) DNA

Q10 OH Group present in Amino Acid
(a) Serine (b) Phenylalanine (c) Alanine (d) all

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Biomolecule

lecture - 04

Botany

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Topics

Enzymes

DOPA

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S-II Proteins are mostly left handed helix ✗

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S-II Polypeptide chain is 1° structure ✓

Q10 S-I H-Bond not Break during denaturation ✗
S-II H-Bond Break during Protein Folding ✗

Enzymes

Some Basic Features

① Biocatalyst – Inc. Speed/Rate of Reaction

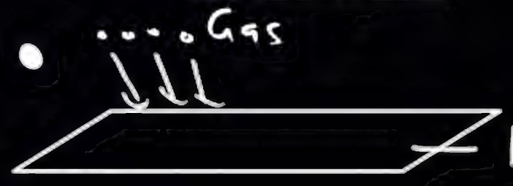
② all Enzymes are protein – Except – Ribozyme – chemically RNA But act as Enzyms

③ Globular protein → All Enzymes are — Water soluble
(All Enzyme Act in Aqueous medium)

(Act with the help of Bile salt)

④ Enzyme like Any other protein → 1° & 2° structure also present
But Enzyme Functional structure → 3° (mainly)
Some Enzyme → 4° structure also present

Inorganic Catalyst



→ Entire Surface Available For Activity

— Temp & Pressure — Inc. Rate of Reaction

Biocatalyst (Enzyme)

- Enzyme – Activity / Reaction occur only Active site

— Very high temp / high pressure (Enzyme — Shape destroy → Inactive Enzym)

Thermophile / organism Found in High temp — Thermostable Enzyme present (Enzyme → high temp not get denature)

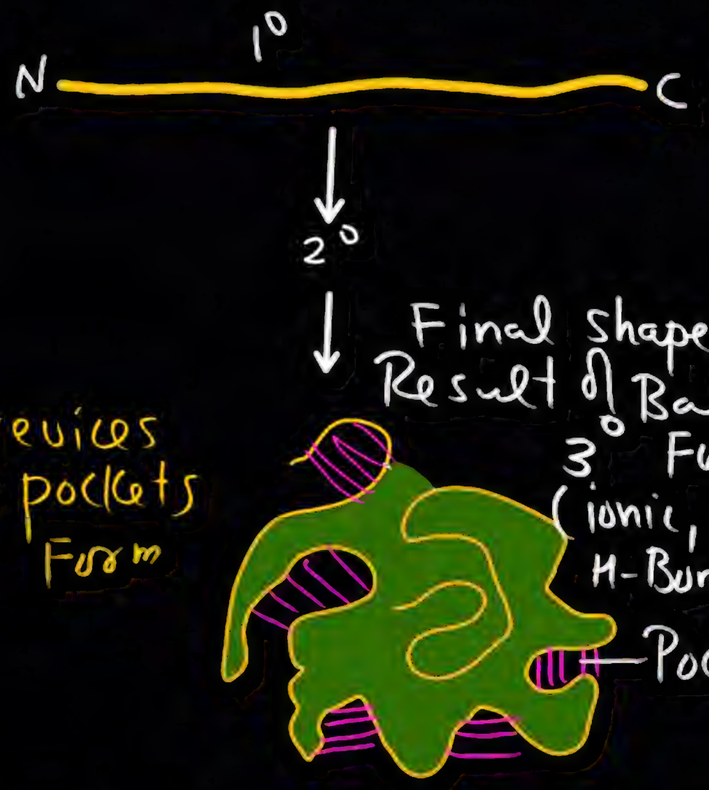
Structure of Enzyme

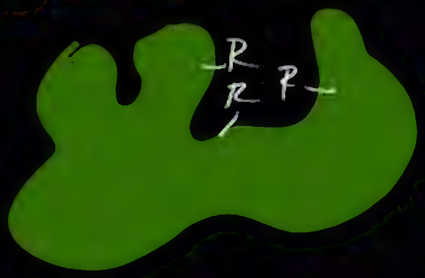
→ Enzyme → Structure – Draw By line

→ Enzyme → 1^0 ⟶ 2^0 ⟶ 3^0 (Final Folding)

– When Enzyme is Finally Folded ⟶ on Surface large no. of Crevices or pockets Form

Any one pocket Act as Active site → on which Substrate Bind





Active site – pocket on Enzyme → Substrate / Reactant Bind

– Fix shape (only particular shape Reactant / substrate Bind

– Some chemical group – help in Reaction

note – change in PH & temp ⟶ Change Shape & Also shape of pocket (Active site)

Type of changes done By Enzyme – In Substrate

Substrate (Reactant) Bind on Active site of Enzyme → Active site change Substrate into product

Two type of changes → physical — change in shape – ⬭ → ▭
Change in phase → Solid → Liquid

Chemical → old Bond Break, new Bond (Chemical Bond) Formation occur

→ Product (Shape change – Physical change
New Bond Form – Chemical Change)

Q Enzyme Active site can perform
(a) physical change (b) Chemical change (c) Change in shape (d) all

Q Which is true
(a) Substrate & product can be chemically same
(b) Substrate & produce can be Physically same
(c) Substrate can Bind Multiple Active site on Enzyme
(d) No change in Enzyme during Rxn

Ex- Hydrolysis of starch

Starch & Glucose - Different Chemically & Physically Both

Feature of Enzymes

I Enzymes are protein

2. Enzyme increase Rate of Reaction → S ⟶ P

S-Substrate
P-Product

(Inc. Rate of Disappearance of Substrate
Inc. Rate of Appearence of product)

3. Turn over number — no. of substrate converted into product By Single Enzyme in unit time

Ex- $H_2O + CO_2 \rightarrow H_2CO_3$ (without Enzyme → 200 molecule / hour)

$H_2O + CO_2 \xrightarrow[\text{Anhydrase}]{\text{Carbonic}} H_2CO_3$ (6×10^5 H_2CO_3 / sec) [Rate Inc. By 10 million time]

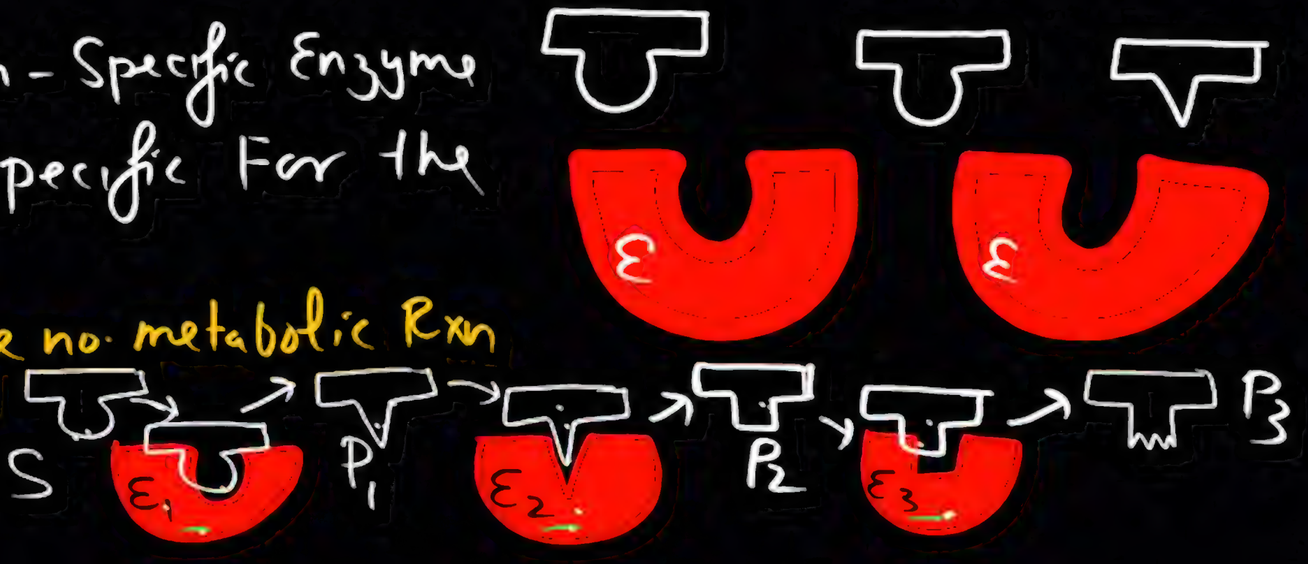
(Highest turnover number)

IV **specificity** – For Every Reaction – Specific Enzyme

– Enzyme Active Site → Shape specific For the Shape of Substrate

Inside cell → large no. of Enzyme | large no. metabolic Rxn

(Product of One Enzyme Substrak For other



Selectivity →

Enzyme can Select one product out of various possibility of product

Pyruvat (3C)

- → Pyruvate dehydrogenase → Acetyl CoA
- → Lactate dehydrogenase → lactic Acid
- → Pyruvate decarboxylase → Acetaldehyde

Mechanism of Enzyme Action

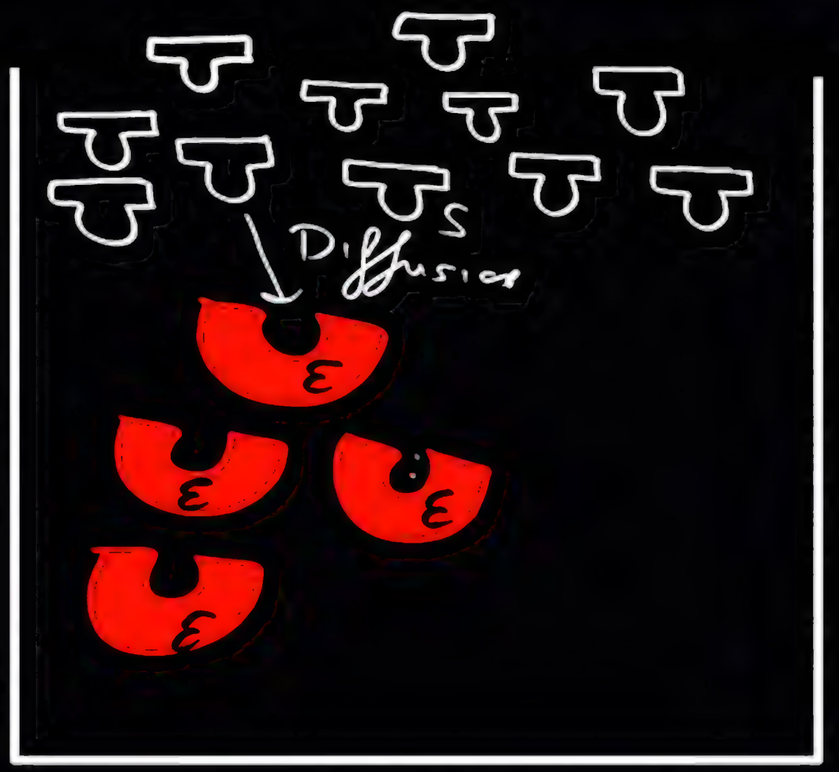
Enzyme - E Substrate - S Product - P

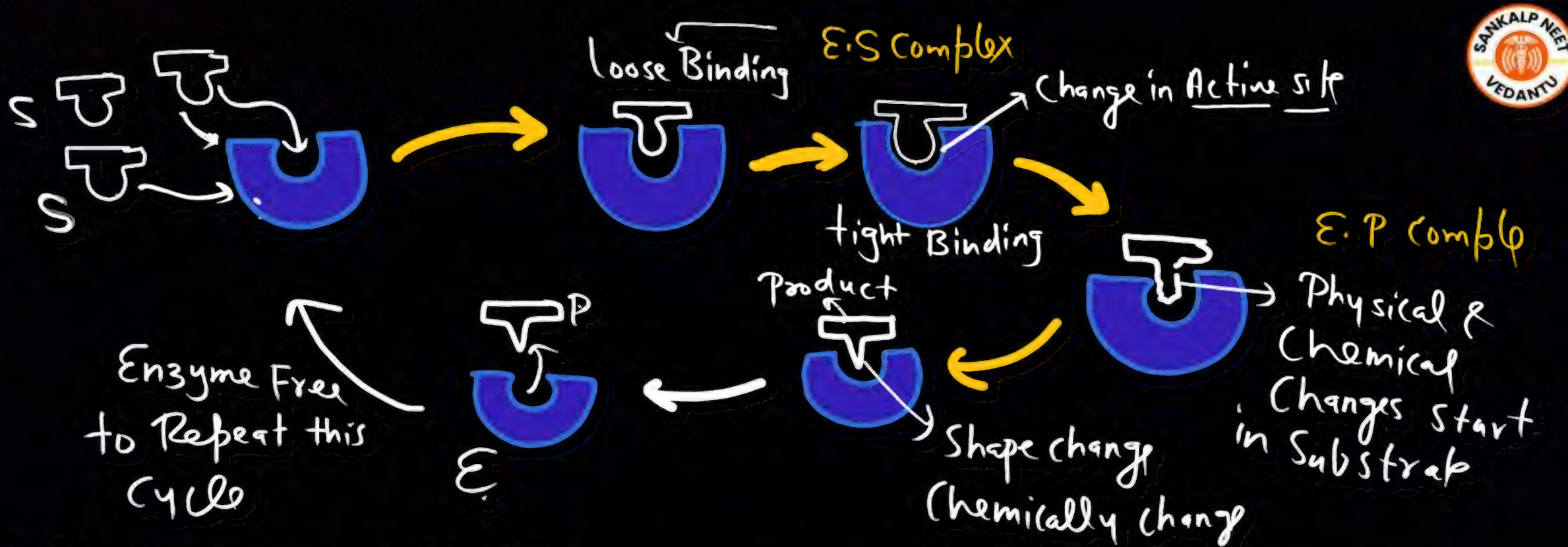
→ ① Enzyme Rxn - Medium Aqueous ✓

② Substrate move towards Enzyme By - Diffusion

③ Substrate can Bind Randomly to Enzyme Anywhere → But when it Bind to Active sites change occur

④ When Substrate on Enzyme Active site initially → loose Binding occur → Shape Change of Enzyme Active site → tight Binding occur → Chemical & Physical Change occur → Product From → Product leave Enzyme





$$E + S \rightleftharpoons E \cdot S \longrightarrow E \cdot P \text{ Complex} \longrightarrow E + P$$

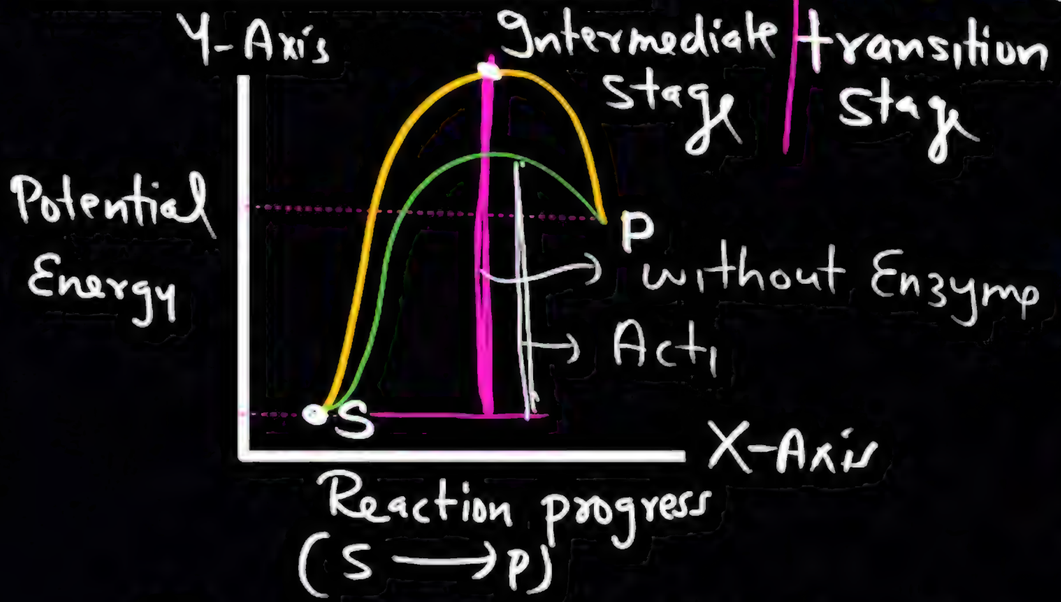
Enzyme Substrate complex

Enzyme Product Complex

Activation Energy

$E + S \rightleftharpoons E \cdot S \longrightarrow E \cdot P \longrightarrow E + P$

$E \cdot S$ Complex, $E \cdot P$ Complex



→ Intermediate stage $[E \cdot S]$ or $[E \cdot P]$ – Unstable

Energy highest

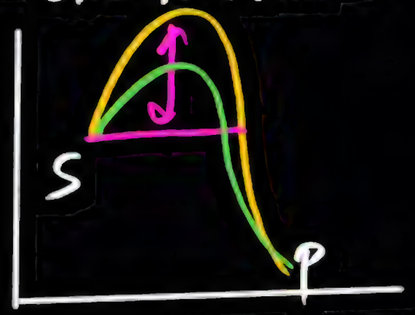
Activation Energy – Average Energy Difference in B/w Energy of substrate & Intermediate (transition stage)

Endothermic → Transition stage (Unstable) > P > S

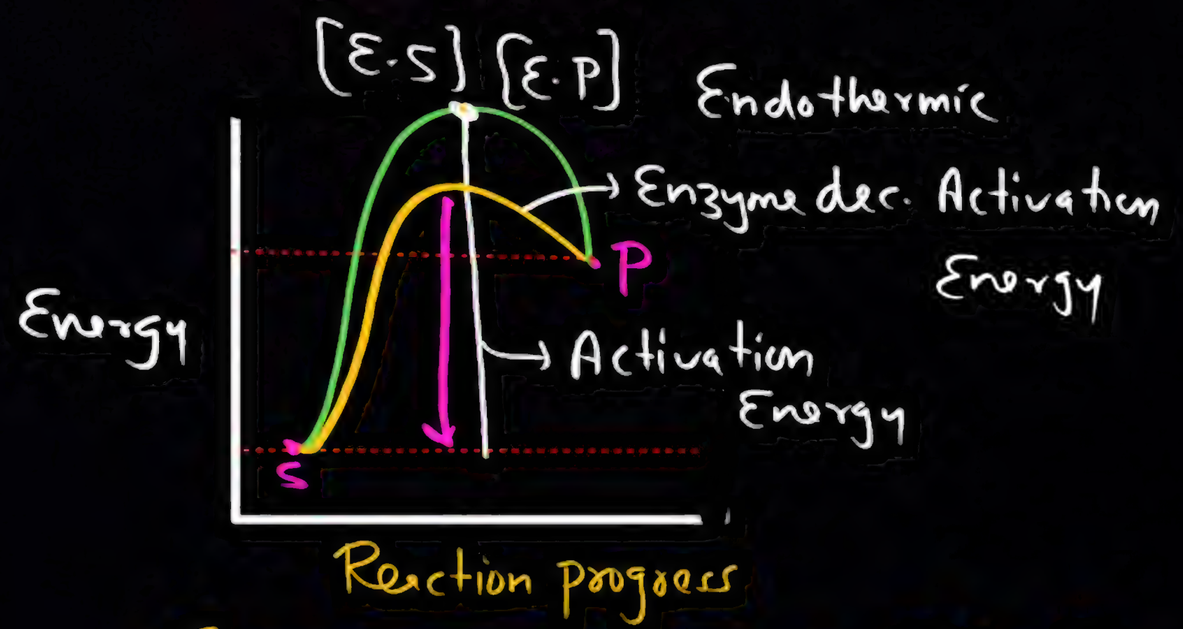
Energy → P > S – Endothermic

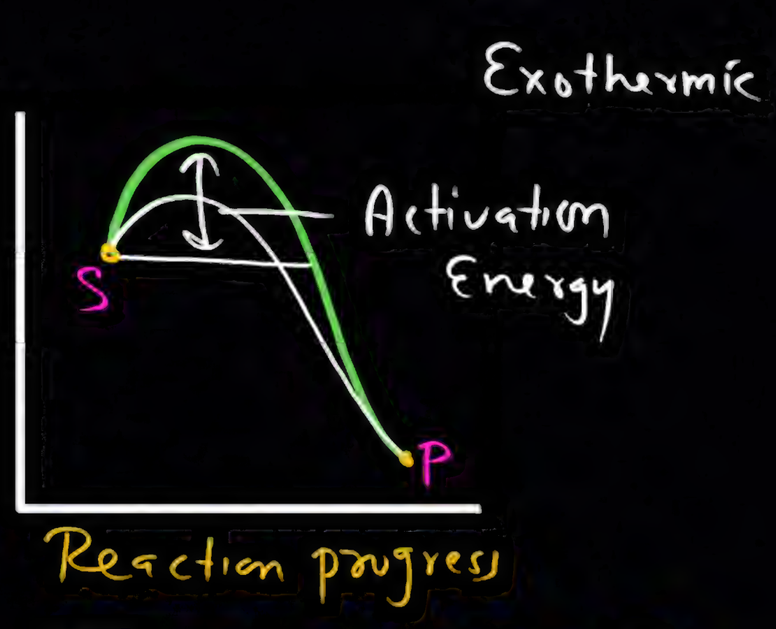
Exothermic → Transition stage > S > P

Energy → S > P – Exothermic



Enzyme dec: Activation Energy





Energy → Transition > P > S

Stage (unstable

Transition > S > P

- Enzyme – no change in Substrate & Product
  - dec. Activation Energy in Both Exothermic & Endothermic

Important points

(a) Substrate move to Enzyme By →

(b) Binding of Substrate to Active site is Random & due to shape

(c) Initial Binding is ____ and change in ____ occur lead to

(d) Chemical and physical change started in

(e) Many transition states Form B|w E·S to E·P complex

(f) In Exothermic → Energy

(g) In Endothermic → Energy

(h) E+S E·S E·P E+P

$$Ba(OH)_2 + H_2SO_4 \rightarrow BaSO_4 + 2H_2O$$

is an inorganic chemical reaction. Similarly, hydrolysis of starch into glucose is an organic chemical reaction. Rate of a physical or chemical process refers to the amount of product formed per unit time. It can be expressed as:

$$\text{rate} = \frac{\delta P}{\delta t}$$

Rate can also be called velocity if the direction is specified. Rates of physical and chemical processes are influenced by temperature among other factors. A general rule of thumb is that rate doubles or decreases by half

for every 10°C change in either direction. Catalysed reactions proceed at rates vastly higher than that of uncatalysed ones. When enzyme catalysed reactions are observed, the rate would be vastly higher than the same but uncatalysed reaction. For example

$$\underset{\text{carbon dioxide}}{CO_2} + \underset{\text{water}}{H_2O} \xrightleftharpoons{\text{Carbonic anhydrase}} \underset{\text{carbonic acid}}{H_2CO_3}$$

In the absence of any enzyme this reaction is very slow, with about 200 molecules of H_2CO_3 being formed in an hour. However, by using the enzyme present within the cytoplasm called carbonic anhydrase, the reaction speeds dramatically with about 600,000 molecules being formed every second. The enzyme has accelerated the reaction rate by about 10 million times. The power of enzymes is incredible indeed!

There are thousands of types of enzymes each catalysing a unique chemical or metabolic reaction. A multistep chemical reaction, when each of the steps is catalysed by the same enzyme complex or different enzymes. is called a metabolic pathway. For example,

$$\text{Glucose} \rightarrow 2 \text{ Pyruvic acid}$$

$$C_6H_{12}O_6 + O_2 \rightarrow 2C_3H_4O_3 + 2H_2O$$

is actually a metabolic pathway in which glucose becomes pyruvic acid through ten different enzyme catalysed metabolic reactions. When you study respiration in Chapter 14 you will study these reactions. At this stage you should know that this very metabolic pathway with one or two additional reactions gives rise to a variety of metabolic end products. In our skeletal muscle, under anaerobic conditions, lactic acid is formed. Under normal aerobic conditions, pyruvic acid is formed. In yeast, during fermentation, the same pathway leads to the production of ethanol (alcohol). Hence, in different conditions different products are possible.

DOPA – 05

(a) S-I correct (b) S-II correct (c) Both S-I & S-II Correct (d) Both wrong

Q1 S-I Enzymes are Globular protein
S-II Substrate come to Enzyme By Diffusion

Q2 S-I Active sites are present in 2° structure of Enzyme
S-II Active site is all crevice on 3° structure

Q3 S-I Substrate move to Enzyme Diffusion
S-II Product move Away From Enzyme By Diffusion

Q4 S-I E·S complex is Reversible
S-II E·P Comple is Reversible

Q5 - S-I - Active site Perform chemical & physical change
S-II Substrate & Product can have same physical structure

Q6 S-I Thermostable Enzyme denature at high temp.
S-II Protein Folding is important For Enzyme to Act

Q7 S-I Exothermic Reaction may Require Enzyme
S-II Endothermic Reaction Require Enzyme

Q8- S-I Activation Energy is Energy barrier which product to cross
S-II Enzyme dec. Activation Energy

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Biomolecule

lecture - 5

Botany

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Topics

Enzymes -02

Enzymes

Some Basic Features

① Biocatalyst – Inc. Speed/Rate of Reaction

② all Enzymes are protein – Except – Ribozyme – chemically RNA But act as Enzyms

③ Globular protein → All Enzymes are — water soluble
(All Enzyme Act in Aqueous medium)

(Act with the help of Bile salt)

④ Enzyme like Any other protein → 1° & 2° structure also present
But Enzyme Functional structure → 3° (mainly)
Some Enzyme → 4° structure also present

Inorganic Catalyst

→ Entire Surface Available For Activity

— Temp & Pressure — Inc. Rate of Reaction

Biocatalyst (Enzyme)

- Enzyme – Activity/Reaction occur only Active site

— Very high temp / high pressure (Enzyme — Shape destroy → Inactive Enzym)

Thermophile / organism Found in High temp — Thermostable Enzyme present (Enzyme → high temp not get denature)

Structure of Enzyme

→ Enzyme → Structure – Draw By line

→ Enzyme → 1^0 ⟶ 2^0 ⟶ 3^0 (Final Folding)

– When Enzyme is Finally Folded ⟶ on Surface large no. of Crevices or pockets Form

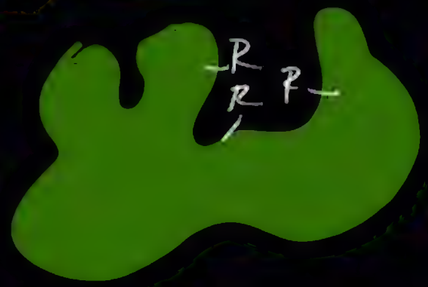
Any one pocket Act as Active site → on which Substrate Bind

Final shape is Result of Balance of 3^0 Forces (ionic, Vander wall H-Bond, S-S Bridge)

Active site – pocket on Enzyme → Substrate / Reactant Bind

– Fix shape (only particular shape Reactant / substrate Bind

– Some chemical group – help in Reaction



note – change in PH & temp ⟶ Change Shape & Also shape of pocket (Active site)

Type of changes done By Enzyme – In Substrate

Substrate (Reactant) Bind on Active site of Enzyme → Active site change Substrate into product

Two type of changes

→ physical — change in shape – ⬭ → ▭
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Ex- Hydrolysis of starch

Starch & Glucose - Different Chemically & Physically Both

Feature of Enzymes

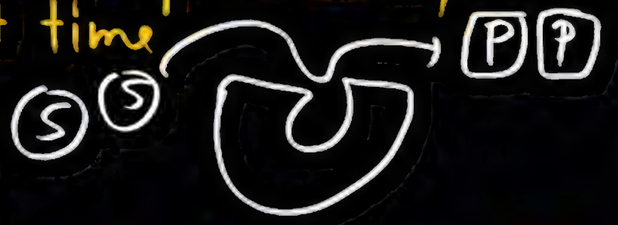
I Enzymes are protein

S-Substrate
P-Product

2. Enzyme increase Rate of Reaction → $S \longrightarrow P$

(Inc. Rate of Disappearance of Substrate
Inc. Rate of Appearence of Product)

3. Turn over number — no. of substrate converted into product By Single Enzyme in unit time



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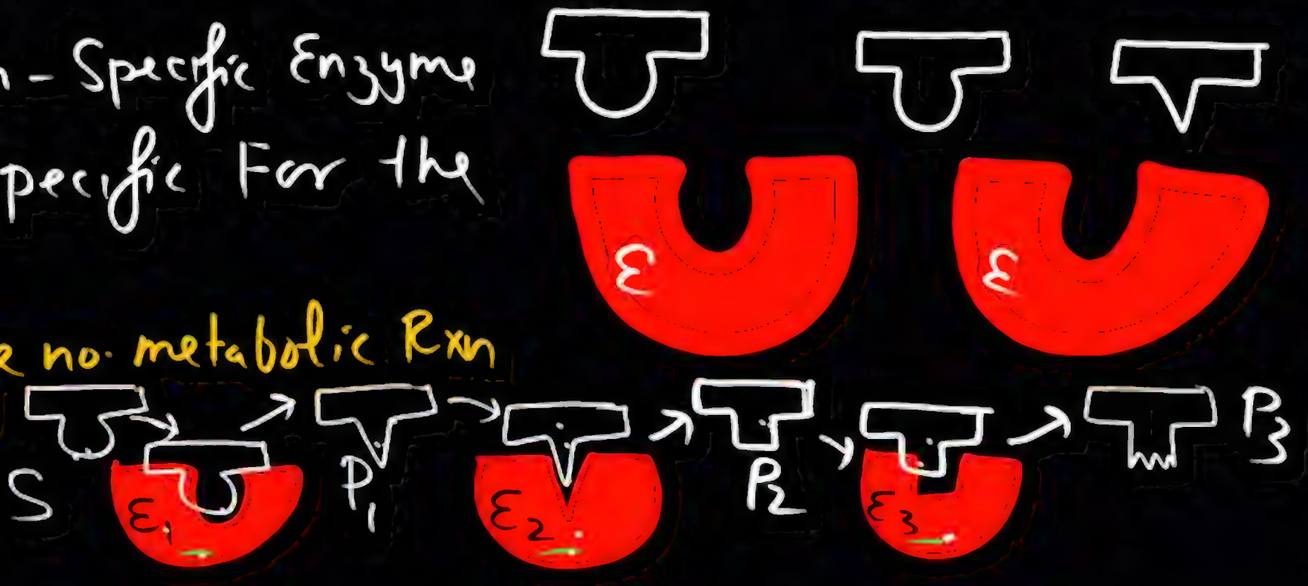

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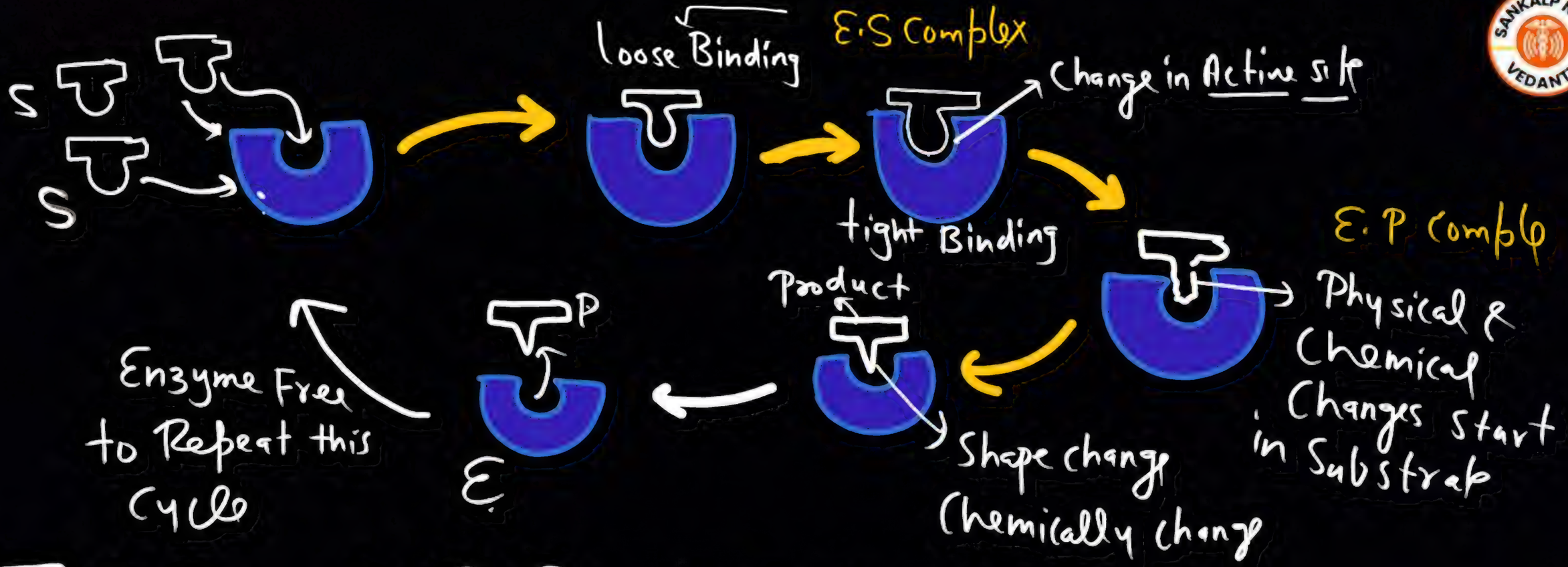


$$E + S \rightleftharpoons E \cdot S \longrightarrow E \cdot P \text{ complex} \longrightarrow E + P$$

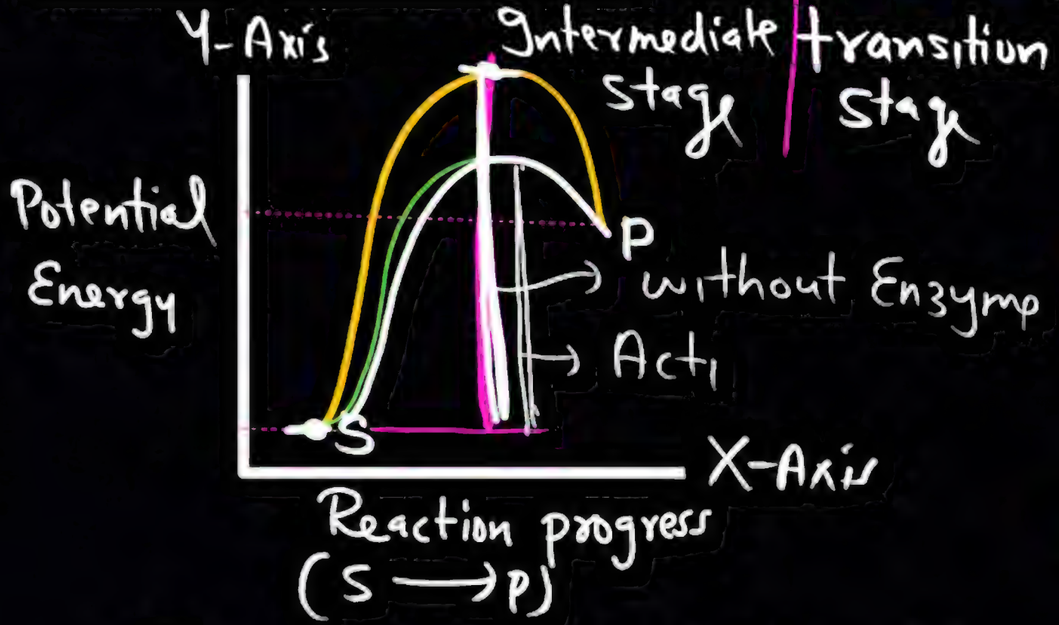
Enzyme Substrate complex

Enzyme Product Complex

Activation Energy

$E + S \rightleftharpoons E \cdot S \longrightarrow E \cdot P \longrightarrow E + P$

$E \cdot S$ Complex $E \cdot P$ Complex



→ Intermediate stage $[E \cdot S]$ or $[E \cdot P]$ – unstable

Energy highest

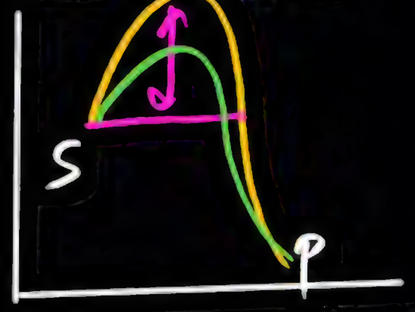
Activation Energy – Average Energy Difference in B/w Energy of substrate & Intermediate (transition stage)

Endothermic → Transition stage (Unstable) > P > S

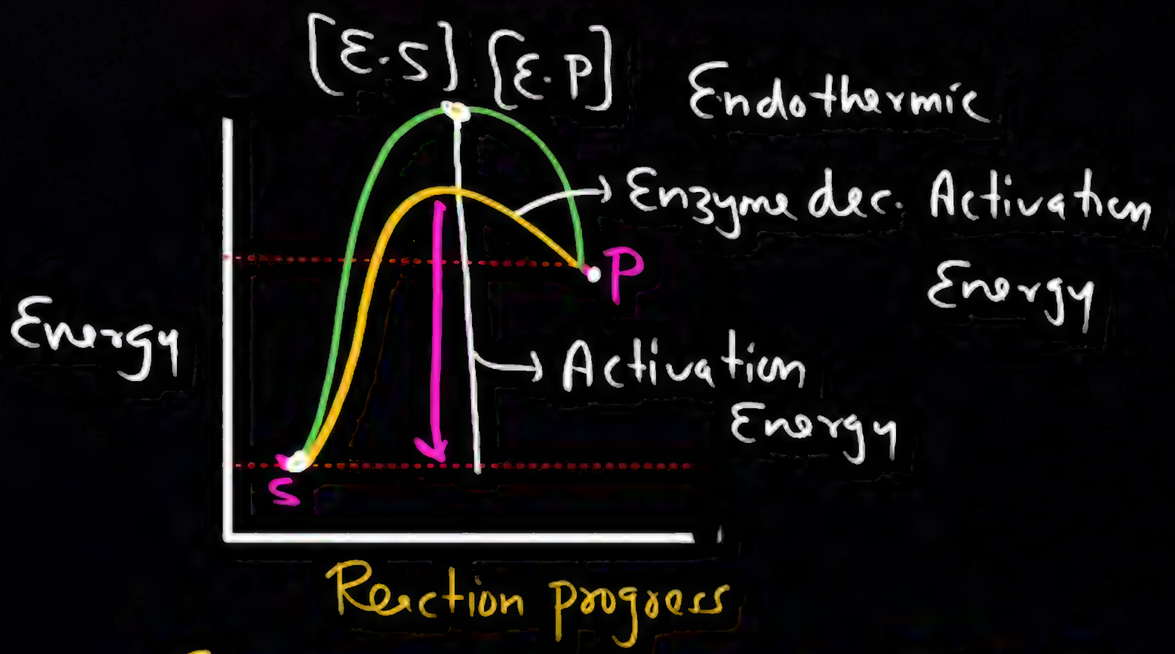
Energy → P > S – Endothermic

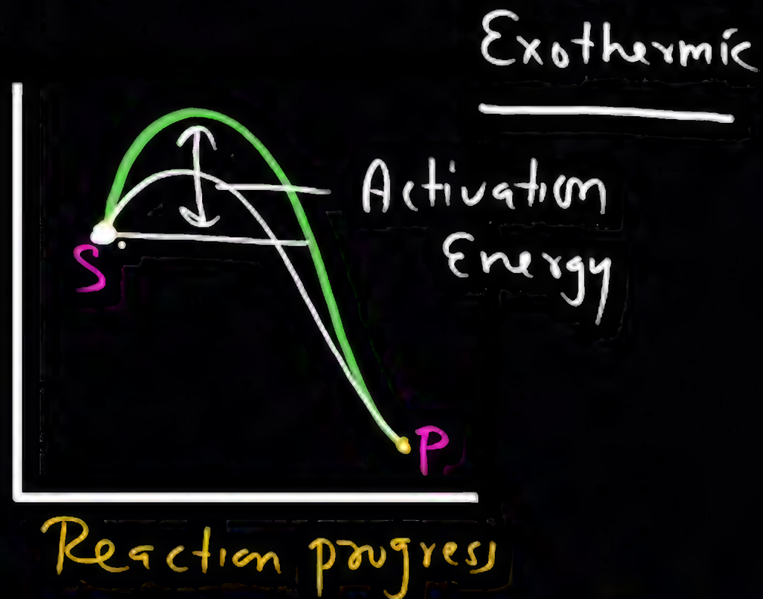
Exothermic → Transition stage > S > P

Energy → S > P – Exothermic



Enzyme dec: Activation Energy





Energy → Transition > P > S

Stage (unstable

Transition > S > P

- Enzyme – no change in Substrate & Product
  - dec. Activation Energy in Both Exothermic & Endothermic

Important points

(a) Substrate move to Enzyme By → Diffusion

(b) Binding of Substrate to Active site is Random & due to shape of Active Site Substrate Bind

(c) Initial Binding is loose and change in Enzyme occur lead to tight Binding

(d) Chemical and physical change started in — Substrate

(e) Many transition states Form B/w E·S to E·P complex

(f) In Exothermic → Energy → T·S > S > P

(g) In Endothermic → Energy → T·S > P > S

(h) $E + S \rightleftharpoons E \cdot S \longrightarrow E \cdot P \longrightarrow E + P$

$$Ba(OH)_2 + H_2SO_4 \rightarrow BaSO_4 + 2H_2O$$

is an inorganic chemical reaction. Similarly, hydrolysis of starch into glucose is an organic chemical reaction. Rate of a physical or chemical process refers to the amount of product formed per unit time. It can be expressed as:

$$\text{rate} = \frac{\delta P}{\delta t}$$

Rate can also be called velocity if the direction is specified. Rates of physical and chemical processes are influenced by temperature among other factors. A general rule of thumb is that rate doubles or decreases by half

for every 10°C change in either direction. Catalysed reactions proceed at rates vastly higher than that of uncatalysed ones. When enzyme catalysed reactions are observed, the rate would be vastly higher than the same but uncatalysed reaction. For example

$$\underset{\text{carbon dioxide}}{CO_2} + \underset{\text{water}}{H_2O} \xrightarrow[\leftarrow]{\text{Carbonic anhydrase}} \underset{\text{carbonic acid}}{H_2CO_3}$$

In the absence of any enzyme this reaction is very slow, with about 200 molecules of H_2CO_3 being formed in an hour. However, by using the enzyme present within the cytoplasm called carbonic anhydrase, the reaction speeds dramatically with about 600,000 molecules being formed every second. The enzyme has accelerated the reaction rate by about 10 million times. The power of enzymes is incredible indeed!

There are thousands of types of enzymes each catalysing a unique chemical or metabolic reaction. A multistep chemical reaction, when each of the steps is catalysed by the same enzyme complex or different enzymes, is called a metabolic pathway. For example,

$$\text{Glucose} \rightarrow 2 \text{ Pyruvic acid}$$

$$C_6H_{12}O_6 + O_2 \rightarrow 2C_3H_4O_3 + 2H_2O$$

is actually a metabolic pathway in which glucose becomes pyruvic acid through ten different enzyme catalysed metabolic reactions. When you study respiration in Chapter 14 you will study these reactions. At this stage you should know that this very metabolic pathway with one or two additional reactions gives rise to a variety of metabolic end products. In our skeletal muscle, under anaerobic conditions, lactic acid is formed. Under normal aerobic conditions, pyruvic acid is formed. In yeast, during fermentation, the same pathway leads to the production of ethanol (alcohol). Hence, in different conditions different products are possible.

DOPA – 05

(a) S-I correct (b) S-II correct (c) Both S-I & S-II Correct (d) Both wrong

Q1 S-I Enzymes are Globular protein ✓
S-II Substrate come to Enzyme By Diffusion ✓

Q2 S-I Active sites are present in (2°) 3° structure of Enzyme ✗
S-II Active site is all crevice on 3° structure ✗

Q3 S-I Substrate move to Enzyme Diffusion ✓
S-II Product move Away From Enzyme By Diffusion ✓

Q4 S-I E·S complex is Reversible ✓
S-II E·P Comple is Reversible ✗

Q5 - S-I - Active site Perform chemical & physical change ✓
S-II Substrate & Product can have some physical structure ✗

Q6 S-I Thermostable Enzyme denature at high temp ✗
S-II Protein Folding is important For Enzyme to Act ✓

Q7 S-I Exothermic Reaction may Require Enzyme ✓
S-II Endothermic Reaction Require Enzyme ✓

Q8- S-I Activation Energy is Energy barrier which product to cross ✗
S-II Enzyme dec. Activation Energy ✓

Factors affecting enzyme activity

- temp
- PH
- Substrate Conc.
- Inhibitor

Temperature → Enzyme Act at narrow Range of temp.

→ Substrate move with Diffusion → temp inc. → Enzyme Activity

Rate of Diffusion ← Increase

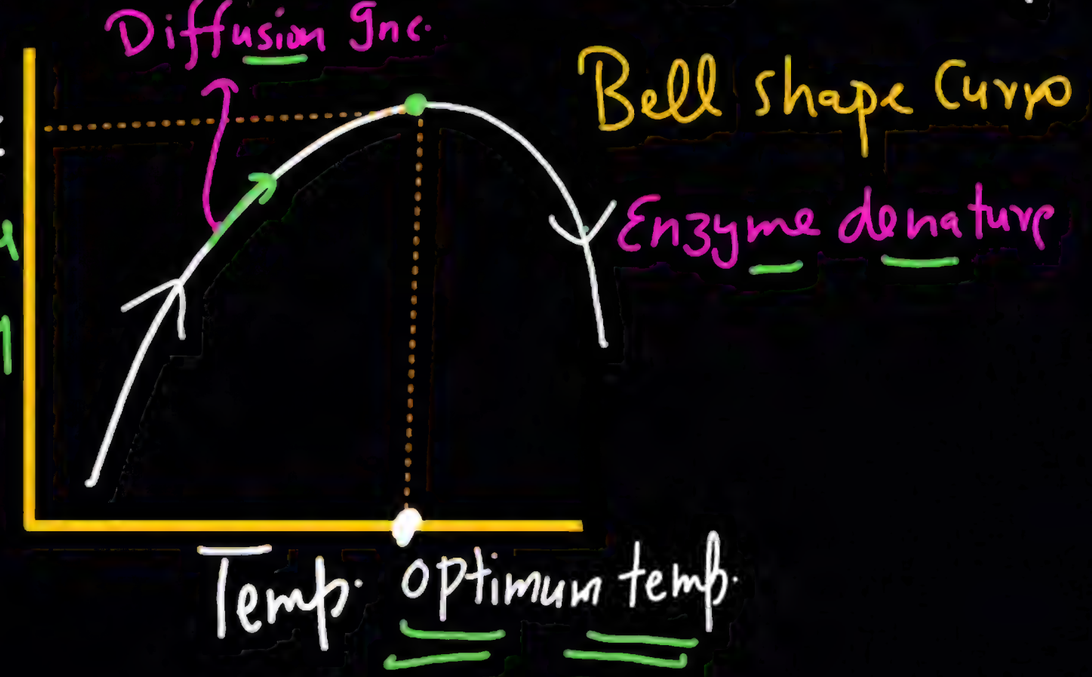
Increase

→ But very high temp → Enzyme shape destroy/denature – Enzyme Activity dec.

→ Initially → temp Inc → Enzyme Activity inc.
Max at temp – optimum temp.

→ Further Inc → Activity dec.

Q Temp. below optimum, Inc in temp
(a) Inc. Activity (b) dec. Activity



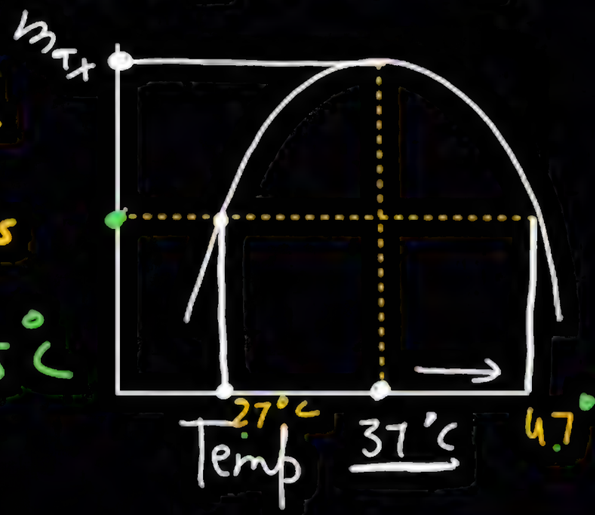
→ Below 10°c → Many Enzyme – less Active – Rate of Diffusion of Substrate dec.

→ Very High temp. → Enzyme destroy/denature → Enzyme Activity decrease

$Q_{10} = 2$ → Both side of optimum temp. Change in 10°c Can dec. Rate to half

15 ← 25 → 35

Q optimum temp of Enzyme → E_1 = 25°c
Enzyme Activity is half (a) 15°c (b) 35°c (c) 25°c (d) Both a & b



Low temp – less Active
High temp – Inactive

37 ↓ 1/2
27 ↓ 1/2
17

Q If Enzyme Activity is Maximum at 37°c then it is 1/4 when temp is
(a) 27°c 1/2 (b) 17°c 1/4 (c) 47°c 1/2 (d) 37°c max

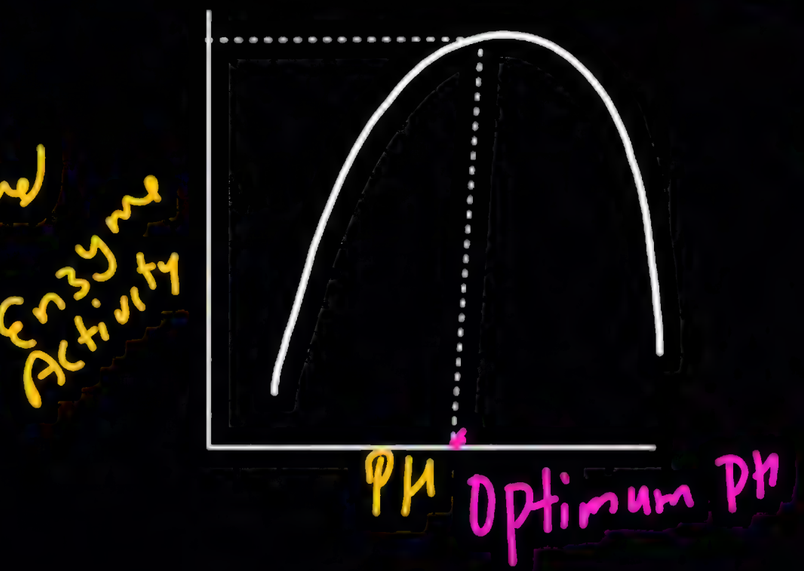
PH

→ Enzyme 3° structure → Balance of Different Forces like ionic interaction, Hydrophobic

→ Every Enzyme need a particular PH → to maintain Shape

→ PH at which shape maintain | PH at which Enzyme is maximum Active — Optimum PH

- Salivary Amylase — 6·8 ✓
- Pepsin — 1·8 (Stomach)
- Trypsin → 7·6 (Small intestine)



Substrate concentration

S - Substrate

[S] = Substrate conc.

→ Amount of Substrate is more than number of Enzyme

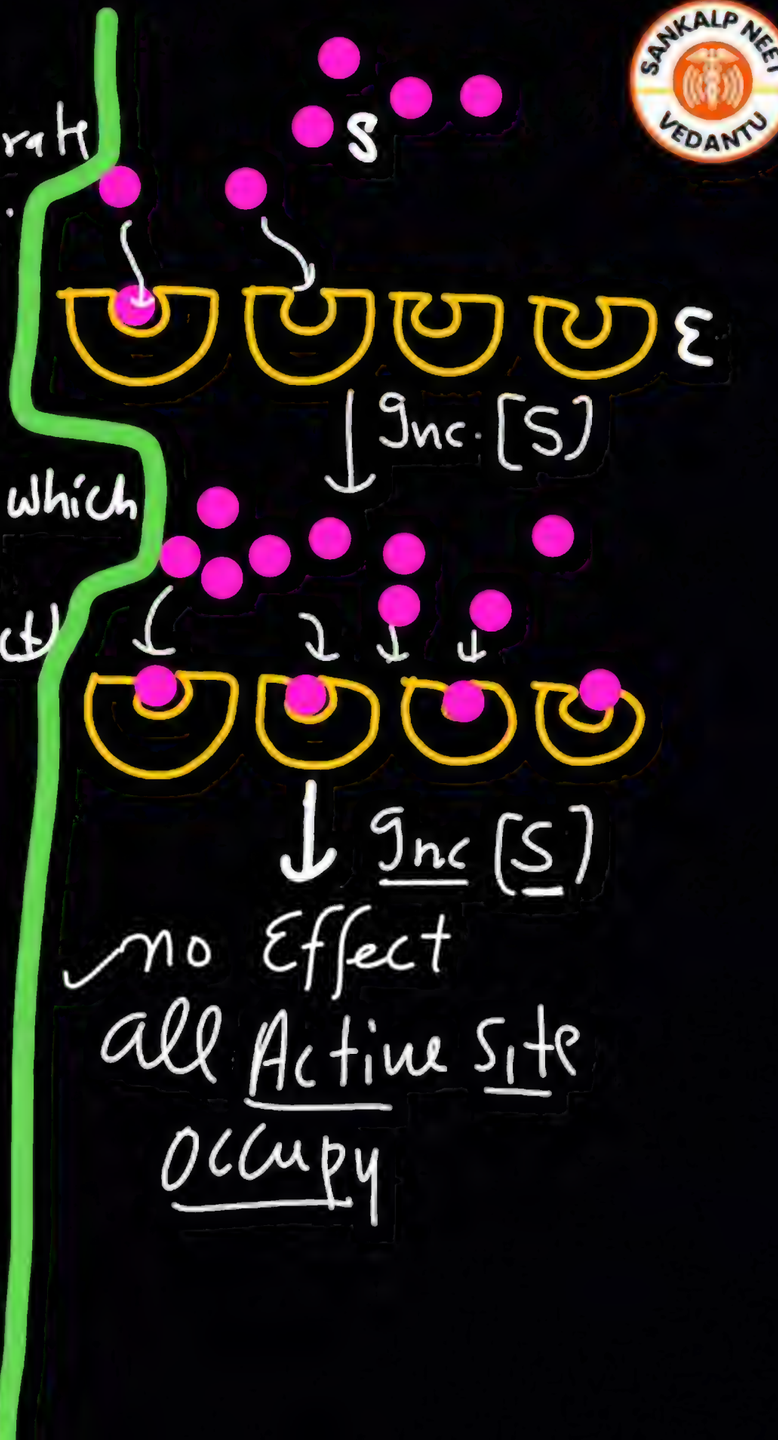
→ Substrate move by Diffusion

→ Inc. in conc. of Substrate → Rate of Diffusion ↓ Enzyme Velocity (Speed By which it Form Product) Inc.

$V \propto [S]$

Velocity of Enzyme

→ Further Inc. in Substrate conc. → All Active Site occupy ← No Inc. in Velocity (Maximum Velocity achieve)



[S]	V
1000	20
2000	40
3000	50
4000	60
5000	60
6000	60

All Active Site occupy

It is not easy to Find [S] - Substrate conc. at which Vmax is achieved

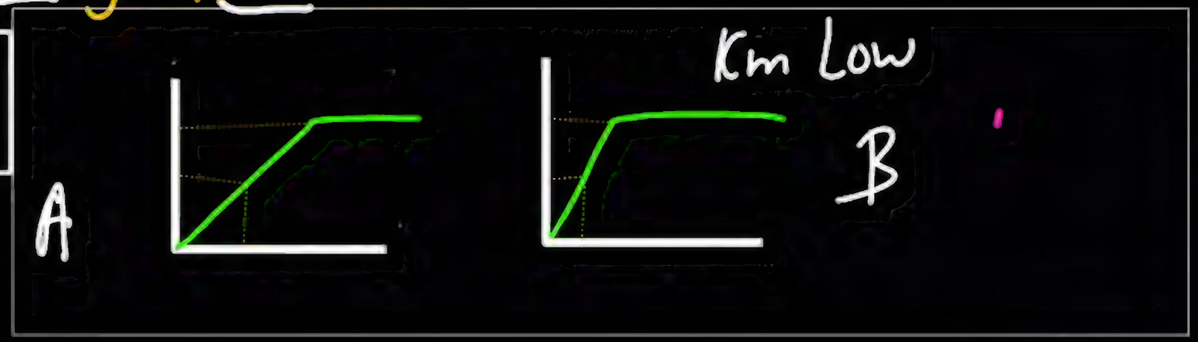
Vmax - maximum Enzyme velocity (All Active sites of all Enzyme occupy)

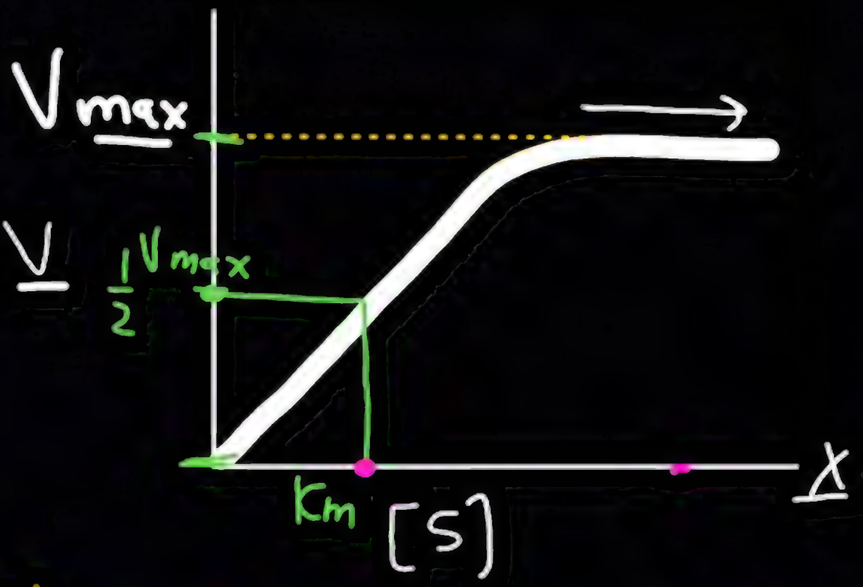
Km [S] Substrate conc.

1/2 Vmax - half of maximum velocity

Km = It is that Substrate conc. at which velocity is half of Vmax

Better Enzyme → Km low

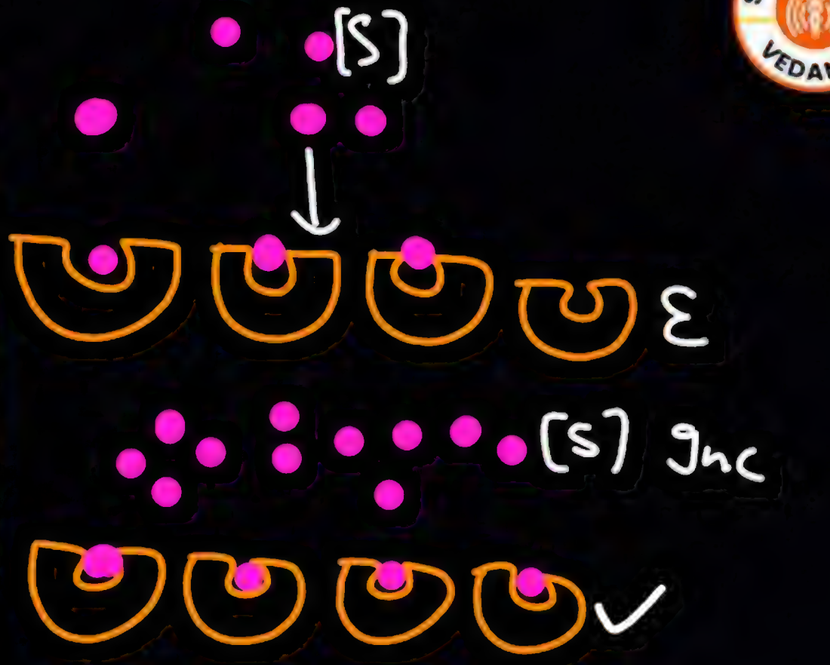




Vmax - Enzyme maximum velocity

Km → Substrate conc. velocity is half of Vmax

[S]	Velocity
10	5 ✓
20	10 ✓
40	16
60	16
80	16



9.12.4 Factors Affecting Enzyme Activity

The activity of an enzyme can be affected by a change in the conditions which can alter the tertiary structure of the protein. These include temperature, pH, change in substrate concentration or binding of specific chemicals that regulate its activity.

Temperature and pH

Enzymes generally function in a narrow range of temperature and pH (Figure 9.7). Each enzyme shows its highest activity at a particular temperature and pH called the optimum temperature and optimum pH. Activity declines both below and above the optimum value. Low temperature preserves the enzyme in a temporarily inactive state whereas high temperature destroys enzymatic activity because proteins are denatured by heat.

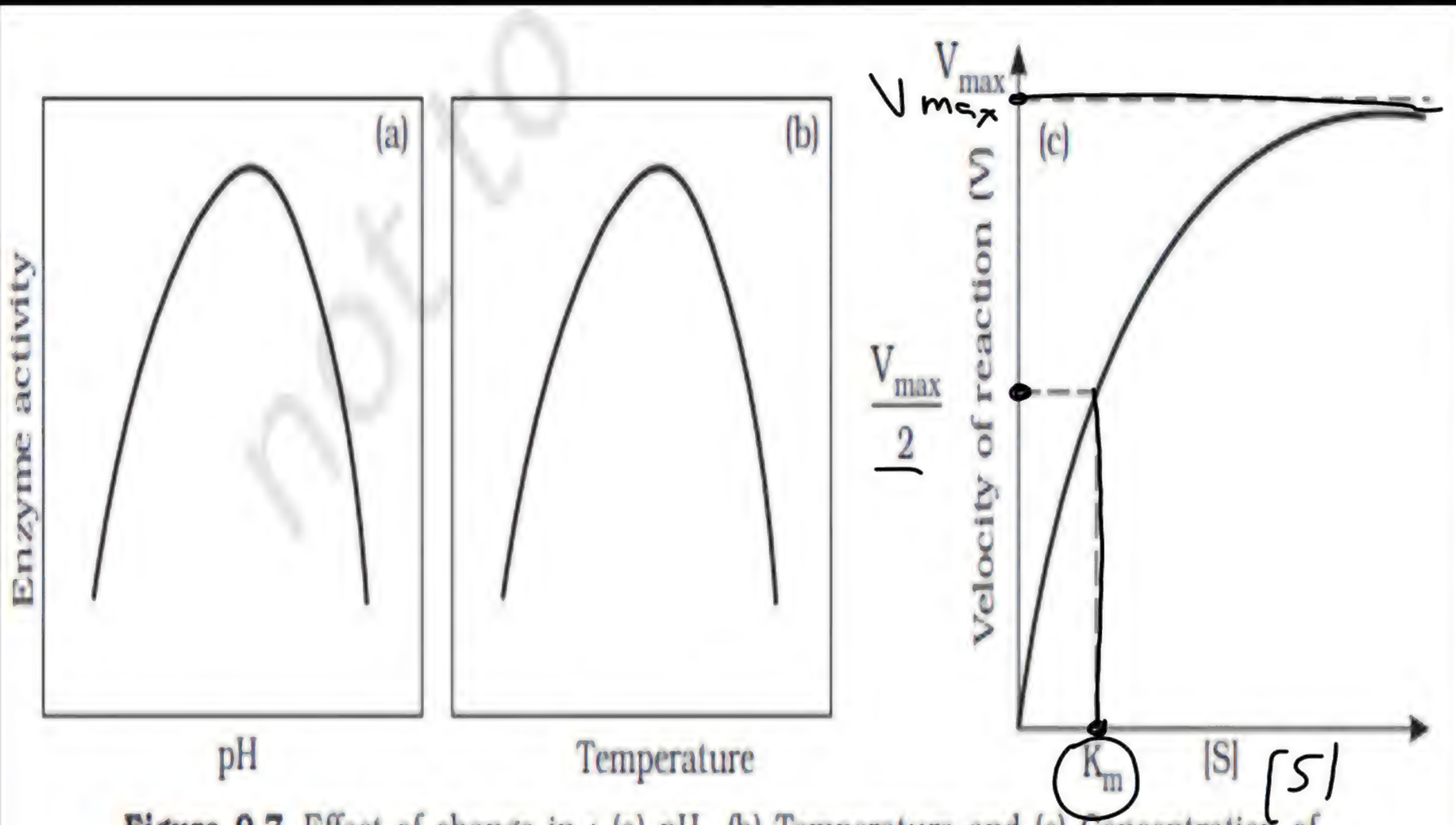


Figure 9.7 Effect of change in : (a) pH (b) Temperature and (c) Concentration of substrate on enzyme activity

Q1 Vmax is

(a) Substrate conc. max

(b) All Enzyme Active site occupied

(c) Half Enzyme Active

(d) none

Q2 Km is

(a) Enzyme conc. (b) Substrate Conc.

Q3 At Km value

(a) max. velocity

(b) Half Active site occupy

(c) all Active site occupy

(d) none

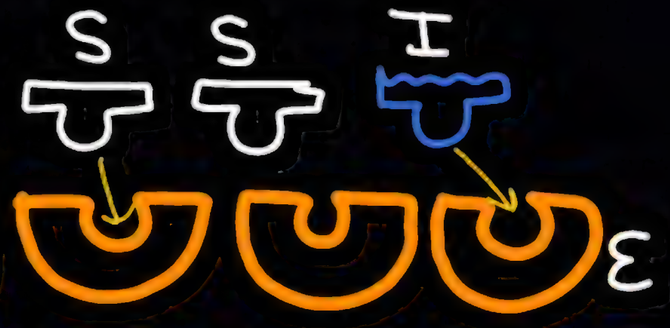
presence of inhibitor

- Inhibitor is Any chemical Enzyme Activity Decrease

Three type of Inhibition (a) Competitive (b) Non-Competitive (c) Feed back

(a) Competitive – Substrate and inhibitor compete For Active site of Enzyme

- Substrate & inhibitor shape same (Physically same) Chemically Different
- Inhibitor not From Product



$[E + I \rightleftharpoons E \cdot I]$ [Enzyme inhibitor complex Reversible]

Ex- Succinate dehydrogenase – E

Substrate ⇒ Succinate

Product → Fumarate

I = Inhibitor = Malonate [note – Succinate & Malonate Shape Same]

How to overcome Competitive inhibition → Inc. Substrate conc.

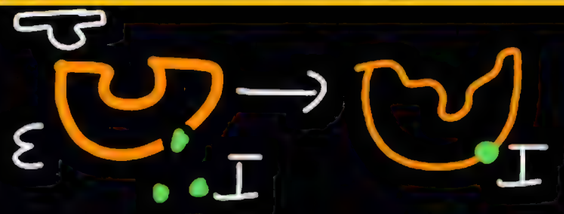
S = 20 ⟶ S = 100
I = 1 I = 1

1/20 Chance of Bind

1/100 Chance of inhibitor to Bind Enzyme

[Vmax – Unchange ✓
Km = Inc. → We need more Substrate For same velocity]

Non-competitive



– Inhibitor Bind to Enzyme other than Active site
→ Enzyme Shape change → Inactive
→ total no. of Enzyme dec ⟶ Vmax – dec.
Km – Unchange

[100 ⟶ 99 (50)]

Ex – Complex Ⅳ / Cytochrome c oxidase
non Competitive Inhibitor – Cyanide

Feed back – product inhibit when Excess
↓
Enzyme

DOPA

Q1 Not true About Enzyme
(a) Globular (b) Shape Fix (c) Inc. Rate of Reaction (d) not useful For Exothermic Rxn

Q2 transition stage in Enzyme catalysed Rxn
(a) Stable (b) Unstable & low Energy (c) Unstable & High Energy (d) none

Q3 Activation Energy is Average Energy Difference B/w Substrate & ____
(a) Product (b) Reactant (c) transition stage (d) Enzyme

Q4 optimum temp is 25°c For Enzyme 'X' at 30°c Enzyme Activity
(a) Maximum (b) lower than optimum (c) Equal to optimum (d) none

Q5 What is optimum temp of Enzyme 'Y' if Enzyme Activity is half of maximum at 10°c & 30°c
(a) 10°c (b) 40°c (c) 30°c (d) 20°c

Q6 When 75% of Active site occupy of Enzyme, inc. [S] conc.
(a) no Effect (b) Inc. velocity (c) dec. velocity (d) all

Q7 Km is that Substrate conc.
(a) 50% Active site occupy (b) 100% Active site occupy (c) no Active site occupy (d) all

Q8 In non-competitive inhibition Vmax
(a) Inc. (b) dec. (c) Unchange (d) all

Q9 S-I Km is low For more Efficient Enzyme
S-II Km is high For more Efficient Enzyme

Q10 S-I Malonate & Fumavate Shape Same
S-II Cyanide is competitive inhibitor

Concentration of Substrate

With the increase in substrate concentration, the velocity of the enzymatic reaction rises at first. The reaction ultimately reaches a maximum velocity (V_{max}) which is not exceeded by any further rise in concentration of the substrate. This is because the enzyme molecules are fewer than the substrate molecules and after saturation of these molecules, there are no free enzyme molecules to bind with the additional substrate molecules (Figure 9.7).

The activity of an enzyme is also sensitive to the presence of specific chemicals that bind to the enzyme. When the binding of the chemical shuts off enzyme activity, the process is called **inhibition** and the chemical is called an **inhibitor**.

When the inhibitor closely resembles the substrate in its molecular structure and inhibits the activity of the enzyme, it is known as **competitive inhibitor**. Due to its close structural similarity with the substrate, the inhibitor competes with the substrate for the substrate-binding site of the enzyme. Consequently, the substrate cannot bind and as a result, the enzyme action declines, e.g., inhibition of succinic dehydrogenase by malonate which closely resembles the substrate succinate in structure. Such competitive inhibitors are often used in the control of bacterial pathogens.

Nomenclature of enzyme

9.12.5 Classification and Nomenclature of Enzymes

Thousands of enzymes have been discovered, isolated and studied. Most of these enzymes have been classified into different groups based on the type of reactions they catalyse. Enzymes are divided into 6 classes each with 4-13 subclasses and named accordingly by a four-digit number.

Oxidoreductases/dehydrogenases: Enzymes which catalyse oxidoreduction between two substrates S and S' e.g.,

$$S_{reduced} + S'_{oxidised} \longrightarrow S_{oxidised} + S'_{reduced}.$$

Transferases: Enzymes catalysing a transfer of a group, G (other than hydrogen) between a pair of substrate S and S' e.g.,

$$S - G + S' \longrightarrow S + S' - G$$

Hydrolases: Enzymes catalysing hydrolysis of ester, ether, peptide, glycosidic, C-C, C-halide or P-N bonds.

Lyases: Enzymes that catalyse removal of groups from substrates by mechanisms other than hydrolysis leaving double bonds.

Isomerases: Includes all enzymes catalysing inter-conversion of optical, geometric or positional isomers.

Ligases: Enzymes catalysing the linking together of 2 compounds, e.g., enzymes which catalyse joining of C-O, C-S, C-N, P-O etc. bonds.

Cofactor

9.12.6 Co-factors

Enzymes are composed of one or several polypeptide chains. However, there are a number of cases in which non-protein constituents called co-factors are bound to the the enzyme to make the enzyme catalytically active. In these instances, the protein portion of the enzymes is called the apoenzyme. Three kinds of cofactors may be identified: prosthetic groups, co-enzymes and metal ions.

Prosthetic groups are organic compounds and are distinguished from other cofactors in that they are tightly bound to the apoenzyme. For example, in peroxidase and catalase, which catalyze the breakdown of hydrogen peroxide to water and oxygen, haem is the prosthetic group and it is a part of the active site of the enzyme.

Co-enzymes are also organic compounds but their association with the apoenzyme is only transient, usually occurring during the course of catalysis. Furthermore, co-enzymes serve as co-factors in a number of different enzyme catalyzed reactions. The essential chemical components of many coenzymes are vitamins, e.g., coenzyme nicotinamide adenine dinucleotide (NAD) and NADP contain the vitamin niacin.

A number of enzymes require metal ions for their activity which form coordination bonds with side chains at the active site and at the same time form one or more cordination bonds with the substrate, e.g., zinc is a cofactor for the proteolytic enzyme carboxypeptidase.

Catalytic activity is lost when the co-factor is removed from the enzyme which testifies that they play a crucial role in the catalytic activity of the enzyme.

9.12 Enzymes

Almost all enzymes are proteins. There are some nucleic acids that behave like enzymes. These are called ribozymes. One can depict an enzyme by a line diagram. An enzyme like any protein has a primary structure, i.e., amino acid sequence of the protein. An enzyme like any protein has the secondary and the tertiary structure. When you look at a tertiary structure (Figure 9.4 b) you will notice that the backbone of the protein chain folds upon itself, the chain criss-crosses itself and hence, many crevices or pockets are made. One such pocket is the 'active site'. An active site of an enzyme is a crevice or pocket into which the substrate fits. Thus enzymes, through their active site, catalyse reactions at a high rate. Enzyme catalysts

pockets are made. One such pocket is the 'active site'. An active site of an enzyme is a crevice or pocket into which the substrate fits. Thus enzymes, through their active site, catalyse reactions at a high rate. Enzyme catalysts differ from inorganic catalysts in many ways, but one major difference needs mention. Inorganic catalysts work efficiently at high temperatures and high pressures, while enzymes get damaged at high temperatures (say above 40°C). However, enzymes isolated from organisms who normally live under extremely high temperatures (e.g., hot vents and sulphur springs), are stable and retain their catalytic power even at high temperatures (upto 80°-90°C). Thermal stability is thus an important quality of such enzymes isolated from thermophilic organisms.

9.12.1 Chemical Reactions

How do we understand these enzymes? Let us first understand a chemical reaction. Chemical compounds undergo two types of changes. A physical change simply refers to a change in shape without breaking of bonds. This is a physical process. Another physical process is a change in state of matter: when ice melts into water, or when water becomes a vapour. These are also physical processes. However, when bonds are broken and new bonds are formed during transformation, this will be called a chemical reaction. For example:

$$Ba(OH)_2 + H_2SO_4 \rightarrow BaSO_4 + 2H_2O$$

$$Ba(OH)_2 + H_2SO_4 \rightarrow BaSO_4 + 2H_2O$$

is an inorganic chemical reaction. Similarly, hydrolysis of starch into glucose is an organic chemical reaction. Rate of a physical or chemical process refers to the amount of product formed per unit time. It can be expressed as:

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Rate can also be called velocity if the direction is specified. Rates of physical and chemical processes are influenced by temperature among other factors. A general rule of thumb is that rate doubles or decreases by half

for every 10°C change in either direction. Catalysed reactions proceed at rates vastly higher than that of uncatalysed ones. When enzyme catalysed reactions are observed, the rate would be vastly higher than the same but uncatalysed reaction. For example

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$$\text{Glucose} \rightarrow 2 \text{ Pyruvic acid}$$

$$C_6H_{12}O_6 + O_2 \rightarrow 2C_3H_4O_3 + 2H_2O$$

is actually a metabolic pathway in which glucose becomes pyruvic acid through ten different enzyme catalysed metabolic reactions. When you study respiration in Chapter 14 you will study these reactions. At this stage you should know that this very metabolic pathway with one or two additional reactions gives rise to a variety of metabolic end products. In our skeletal muscle, under anaerobic conditions, lactic acid is formed. Under normal aerobic conditions, pyruvic acid is formed. In yeast, during fermentation, the same pathway leads to the production of ethanol (alcohol). Hence, in different conditions different products are possible.

9.12.2 How do Enzymes bring about such High Rates of Chemical Conversions?

To understand this we should study enzymes a little more. We have already understood the idea of an 'active site'. The chemical or metabolic conversion refers to a reaction. The chemical which is converted into a product is called a 'substrate'. Hence enzymes, i.e. proteins with three dimensional structures including an 'active site', convert a substrate (S) into a product (P). Symbolically, this can be depicted as:

$$S \rightarrow P$$

It is now understood that the substrate 'S' has to bind the enzyme at its 'active site' within a given cleft or pocket. The substrate has to diffuse

towards the 'active site'. There is thus, an obligatory formation of an 'ES' complex. E stands for enzyme. This complex formation is a transient phenomenon. During the state where substrate is bound to the enzyme active site, a new structure of the substrate called transition state structure is formed. Very soon, after the expected bond breaking/making is completed, the product is released from the active site. In other words, the structure of substrate gets transformed into the structure of product(s). The pathway of this transformation must go through the so-called transition state structure. There could be many more 'altered structural states' between the stable substrate and the product. Implicit in this statement is the fact that all other

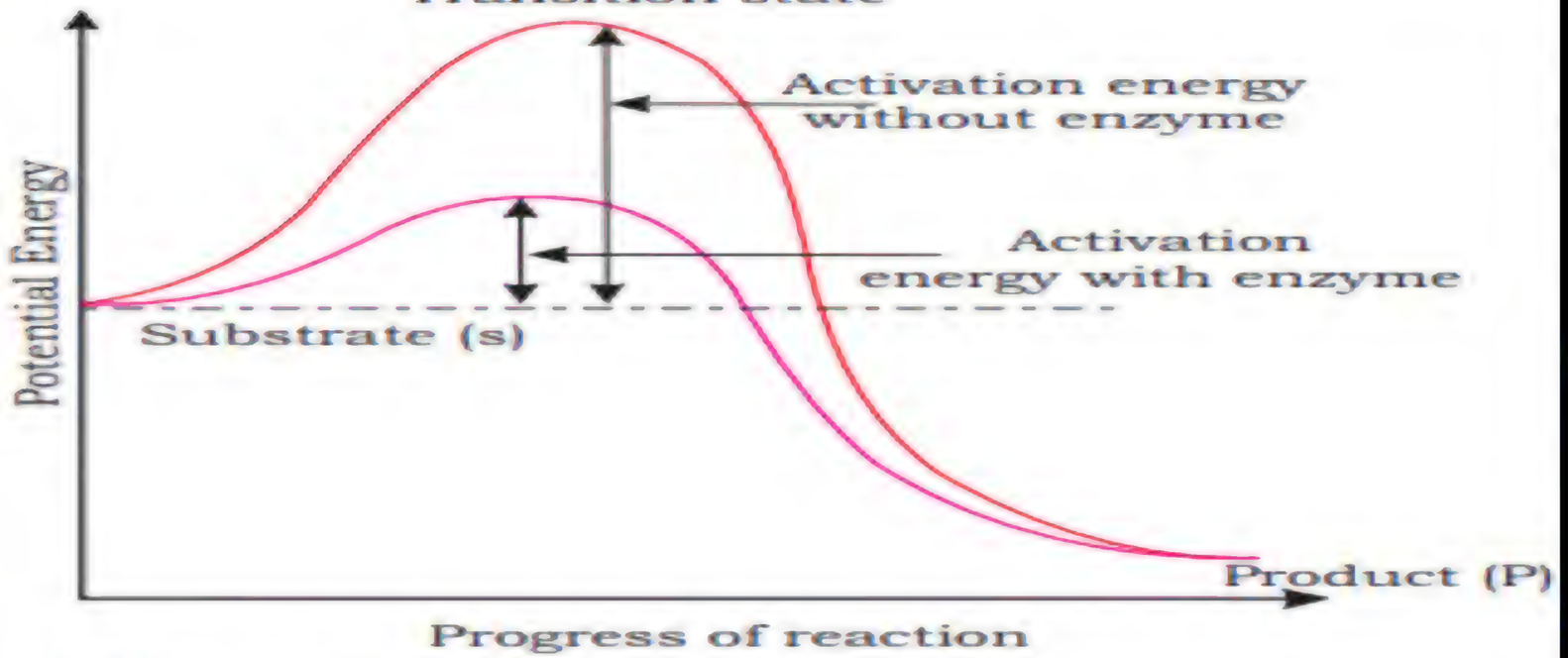

Figure 9.6 Concept of activation energy

intermediate structural states are unstable. Stability is something related to energy status of the molecule or the structure. Hence, when we look at this pictorially through a graph it looks like something as in Figure 9.6.

The y-axis represents the potential energy content. The x-axis represents the progression of the structural transformation or states through the 'transition state'. You would notice two things. The energy level difference between S and P. If 'P' is at a lower level than 'S', the reaction is an exothermic reaction. One need not supply energy (by heating) in order to form the product. However, whether it is an exothermic or spontaneous reaction or an endothermic or energy requiring reaction, the 'S' has to go through a much higher energy state or transition state. The difference in average energy content of 'S' from that of this transition state is called 'activation energy'.

Enzymes eventually bring down this energy barrier making the transition of 'S' to 'P' more easy.

9.12.3 Nature of Enzyme Action

Each enzyme (E) has a substrate (S) binding site in its molecule so that a highly reactive enzyme-substrate complex (ES) is produced. This complex is short-lived and dissociates into its product(s) P and the unchanged enzyme with an intermediate formation of the enzyme-product complex (EP).

The formation of the ES complex is essential for catalysis.

$$E + S \rightleftharpoons ES \longrightarrow EP \longrightarrow E + P$$

The catalytic cycle of an enzyme action can be described in the following steps:

1. First, the substrate binds to the active site of the enzyme, fitting into the active site.
2. The binding of the substrate induces the enzyme to alter its shape, fitting more tightly around the substrate.
3. The active site of the enzyme, now in close proximity of the substrate breaks the chemical bonds of the substrate and the new enzyme- product complex is formed.
4. The enzyme releases the products of the reaction and the free enzyme is ready to bind to another molecule of the substrate and run through the catalytic cycle once again.

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MANTHAN NEET 2025 - 1.0 & 2.0

SANKALP NEET VEDANTU

Biomolecule

lecture — 6

Botany

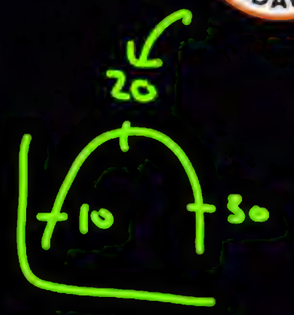
TARUN SIR

Topics

Enzymes -02

DOPA

Q1 Not true About Enzyme
(a) Globular (b) Shape Fix (c) Inc. Rate of Reaction (d) not useful For Exothermic Rxn



Q2 transition stage in Enzyme catalysed Rxn
(a) Stable (b) Unstable & low Energy (c) Unstable & High Energy (d) none

10°c - 1/2
30°c -

Q3 Activation Energy is Average Energy Difference B/w Substrate & ____
(a) Product (b) Reactant (c) transition stage (d) Enzyme

Q4 optimum temp is 25°c For Enzyme 'X' at 30°c Enzyme Activity
(a) Maximum (b) lower than optimum (c) Equal to optimum (d) none

Q5 What is optimum temp of Enzyme 'Y' if Enzyme Activity is half of maximum at 10°c & 30°c
(a) 10°c (b) 40°c (c) 30°c (d) 20°c

$[S] \propto V$

Q6 When 75% of Active site occupy of Enzyme, inc. [S] conc.
(a) no Effect (b) Inc. velocity (c) dec. velocity (d) all

Q7 Km is that Substrate conc.
(a) 50% Active site occupy (b) 100% Active site occupy (c) no Active site occupy (d) all

Q8 In non-competitive inhibition Vmax
(a) Inc. (b) dec. (c) Unchange (d) all

Q9 S-I Km is low For more Efficient Enzyme ✓
S-II Km is high For more Efficient Enzyme ✗

Q10 S-I Malonate & Fumavate (Product) Shape Same ✗
S-II Cyanide is competitive inhibitor ✗

Concentration of Substrate

With the increase in substrate concentration, the velocity of the enzymatic reaction rises at first. The reaction ultimately reaches a maximum velocity (V_{max}) which is not exceeded by any further rise in concentration of the substrate. This is because the enzyme molecules are fewer than the substrate molecules and after saturation of these molecules, there are no free enzyme molecules to bind with the additional substrate molecules (Figure 9.7).

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Nomenclature of enzyme

IUB – International union Biochemist → Enzyme nomenclature → 4 Digit → Code Each Enzyme

Ex → Pyruvate dehydrogenase → 1.3.12.5

Enzyme Classify → 6 Classes & [4 - 13 Subgroup]

O T H L I L

I **oxidoreductase** → Enzyme involve in oxidation & Reduction Rxn

$H\text{-}S_{(substrate)} + S' \longrightarrow S + S'\text{-}H$

(oxidise) (Reduce)

Ex – Dehydrogenase

II **Transferase** → Group transfer (other than Hydrogen)

Glucose + ATP ⟶ Glucose-6-phosphate + ADP

III **Hydrolase** – In presence of water – Break – Ether, Ester, peptide, glycosidic, C-C

Sucrose (G-F) + H_2O ⟶ (Invertase) Glucose + Fructose

Q Which is Class III Enzyme → (a) Hexokinase (b) Alcohol dehydrogenase ~~(c) Amylase~~ (d) all

Nomenclature of enzyme

IV lyase → Double Bond introduce ⟶ By Removing two Group (not water)

OTHLIL

V Isomerase – Form Isomers (Positional isomer (3PG ⟶ 2PG), Structural Isomer, Stereo isomer)

VI Ligase — link C-C, C-N, C-O

Ex – DNA ligase

Q Double Bond introduce By Enzyme

(a) Hydrolase ×

(b) Class IV ✓

(c) Remove water ×

(d) Class VI ×

Q Citrate to Isocitrate Enzyme

(a) Class I 1.3.4.5

(b) Class III 2.13.2.3

(c) Class V 5.2.4.6

(d) Class VI 6.13.4.5

Q DNA ligase correct name

(a) 1 4.5.3

(b) 3 4.13.2

(c) 14.2.3.1

(d) 6 1.6.7

Isomerases: Includes all enzymes catalysing inter-conversion of optical, geometric or positional isomers.

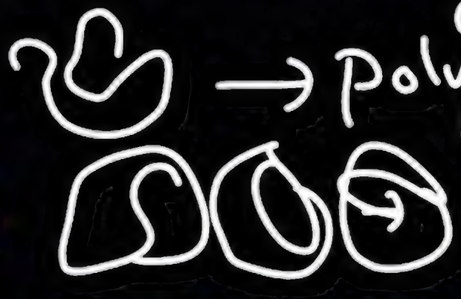
Ligases: Enzymes catalysing the linking together of 2 compounds, e.g., enzymes which catalyse joining of C-O, C-S, C-N, P-O etc. bonds.

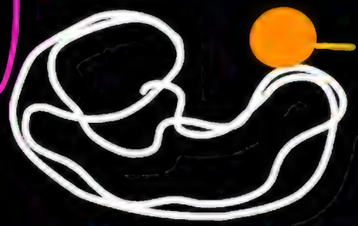
Cofactor

→ Enzymes have one or more polypeptide chain

→ Some Enzymes – which is made up of only polypeptide chain

→ Some Enzymes → Protein + non-protein (Cofactor) = Holo Enzyme
Apoenzyme





Cofactor → (a) non-protein part of Enzyme

(b) Present close to Active Site

(c) help in catalytic Activity

(d) Cofactor Remove → Catalytic Activity dec X
Catalytic Activity lost ✓

Q which is Catalytically Active
(a) Apoenzyme (b) Cofactor
(c) Holoenzyme (d) all

Type of Cofactor

organic cofactor .

Inorganic cofactor

Prosthetic group

(Covalent Bond)

tightly Bound

(Close to Active ste)

(not Possible to Remove Prosthetic Group)

Ex- Heme is prosthetic Group

For Catalase & Peroxidase

$H_2O_2 \longrightarrow H_2O + O_2$

Coenzyme — organic

- Active site come when Rxn perform (Transiently Bind)
- Normally Derivative of Vitamins

NAD - Nicotine Amide Adenine Dinucleotide

NADP } → Come From Niacin

TPP - Thiamine Pyrophosphate

Vit-B_1 derive

△ → Vitamin

✡ → Coenzyme → Active site help

Type of cofactor

organic

- Prosthetic Group
- Coenzyme
  - Ex- NAD^+, $NADP^+$ } From Niacin
  - Coenzyme A
  - TPP

Inorganic cofactor – Metal ion

→ Metal ion → Coordinate Bond on Active site & Substrate

- Ex- Zn → Alcohol dehydrogenase, Carbonic Anhydrase, Carboxy Peptidase
- → Mg^{+2} → Hexokinase, Pyruvate dehydrogenase, RUBISCO, PEPcase
- $-Cl^-$ → Salivary Amylase
- → Fe, Mo → Nitrogenase

9.12.6 Co-factors

Enzymes are composed of one or several polypeptide chains. However, there are a number of cases in which non-protein constituents called co-factors are bound to the the enzyme to make the enzyme catalytically active. In these instances, the protein portion of the enzymes is called the apoenzyme. Three kinds of cofactors may be identified: prosthetic groups, co-enzymes and metal ions.

Prosthetic groups are organic compounds and are distinguished from other cofactors in that they are tightly bound to the apoenzyme. For example, in peroxidase and catalase, which catalyze the breakdown of hydrogen peroxide to water and oxygen, haem is the prosthetic group and it is a part of the active site of the enzyme.

Co-enzymes are also organic compounds but their association with the apoenzyme is only transient, usually occurring during the course of catalysis. Furthermore, co-enzymes serve as co-factors in a number of different enzyme catalyzed reactions. The essential chemical components of many coenzymes are vitamins, e.g., coenzyme nicotinamide adenine dinucleotide (NAD) and NADP contain the vitamin niacin.

A number of enzymes require metal ions for their activity which form coordination bonds with side chains at the active site and at the same time form one or more cordination bonds with the substrate, e.g., zinc is a cofactor for the proteolytic enzyme carboxypeptidase.

Catalytic activity is lost when the co-factor is removed from the enzyme which testifies that they play a crucial role in the catalytic activity of the enzyme.

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Biomolecule

lecture - 7

Botany

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Nucleic Acid

Nucleic Acid

Example

RNA – Ribonucleic Acid
DNA – Deoxyribonucleic Acid

In all living cell ⟶ DNA → Double strand & Genetic material
(Eukaryotes, Prokaryotes)

RNA → Single strand (living cell →
↳ Copy of DNA

note – only virus → RNA as a genetic material

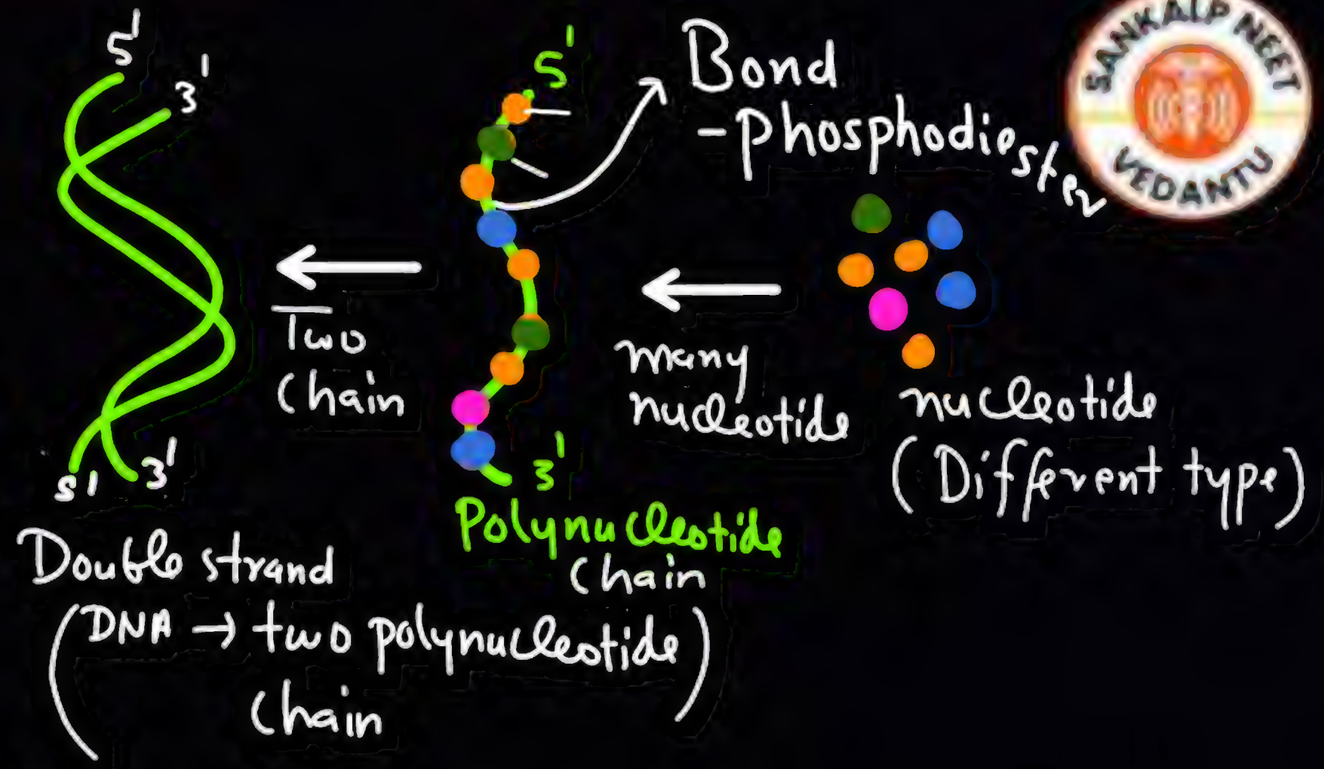
structure of nucleic Acid

→ DNA and RNA – Both made up of Polynucleotide chain

→ DNA ⟶ two chain (Double strand)
RNA → Single chain (Single strand)

→ Polynucleotide chain is made up of many nucleotide

→ First we need to study → Structure of nucleotide



Q which is incorrect For DNA

(a) have polynucleotide chain (b) – ve charge (c) Homopolymer (d) Heteropolymer

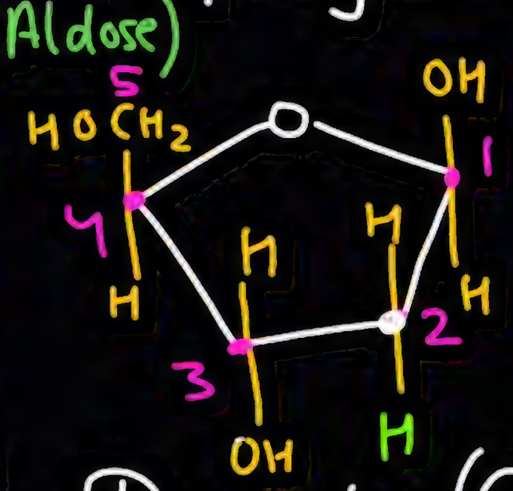
structure of nuclotide

Phosphate — Sugar — Nitrogenous Base] Three Part

I: Sugar → 5C, Ribose, Ring structure (Aldose)

& In DNA-Deoxyribose

$C_5H_{10}O_5$ (Ribose)



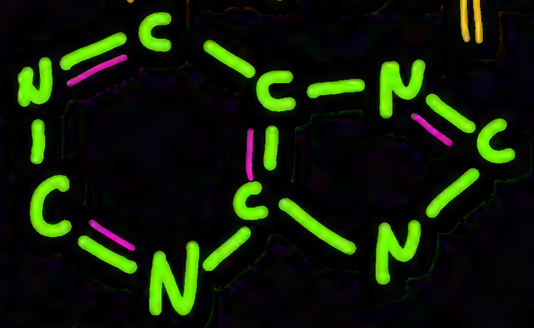
Deoxyribose ($C_5H_{10}O_4$)

thiamine – Vit B_1

thymine – N·B

II Nitrogenous Bases

Total 5 type → Two type of Ring



Purine

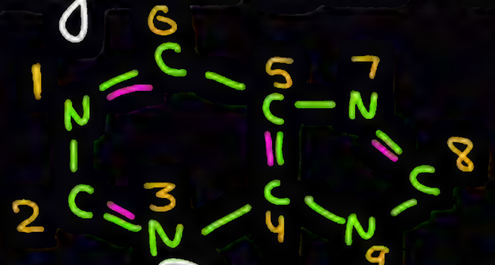
1. Adenine ✓
2. Guanine ✓

Pyrimidine

3. Cytosine
4. Uracil
5. thymine

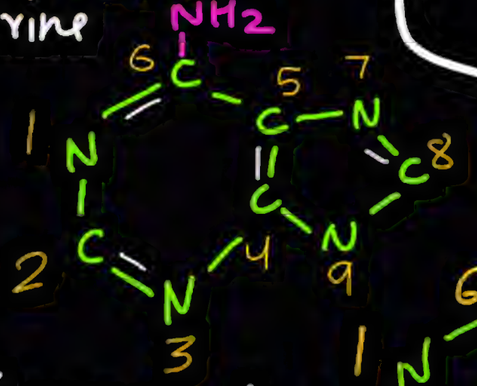
Nitrogenous Bases → Two type of Ring

Ammonia → 1 N
Urea → 2 N
Uric Acid → Purine (4 N)

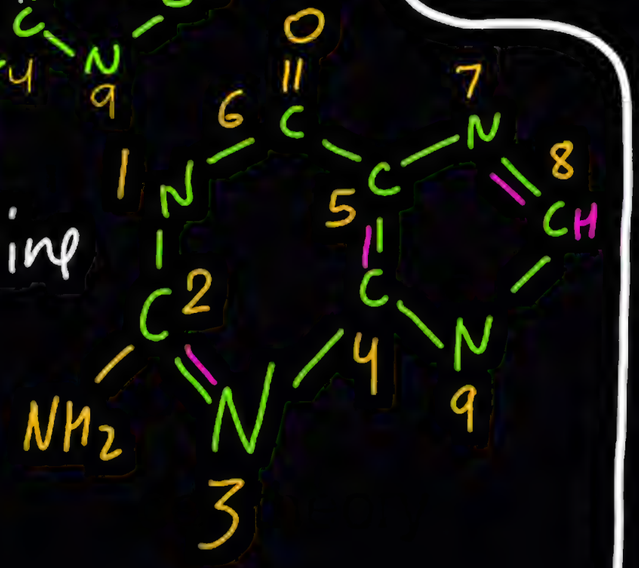


Purine (two Ring) 9 member

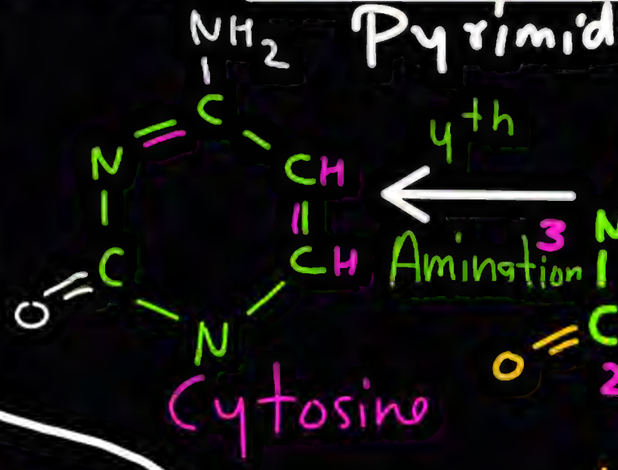
Adenine – 6-Amino purine



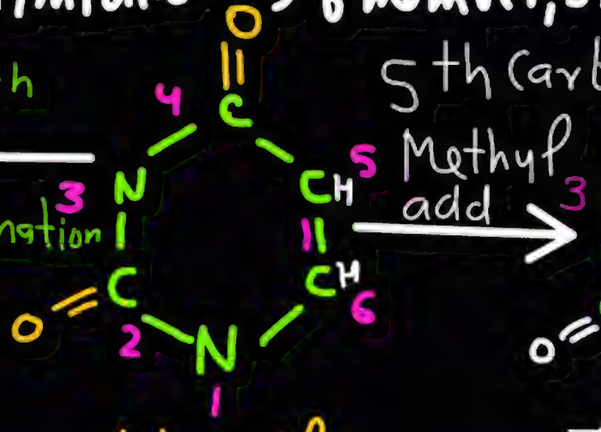
Guanine → 2 Amino, 6 oxo purine



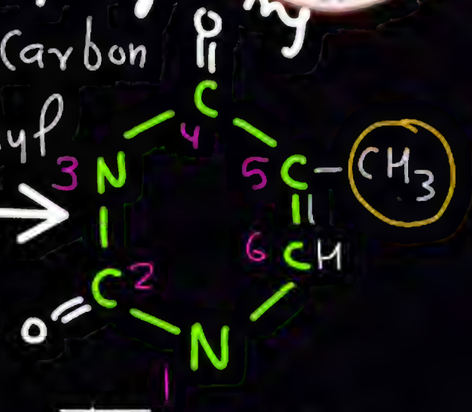
Pyrimidine → 6 member, Single ring



Cytosine



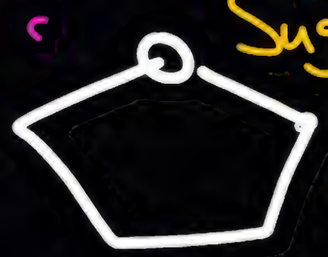
Uracil (2,4 Dioxo Pyrimidine)



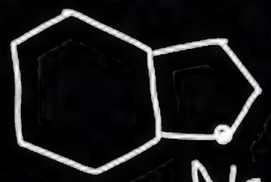
Thymine (5-methyl Uracil)

U —(4th, NH2)→ C
U —(5th, Methyl)→ T

Nucleoside → Sugar → C-1 link with Nitrogenous Bases



C-1 ⟶ link with N·B

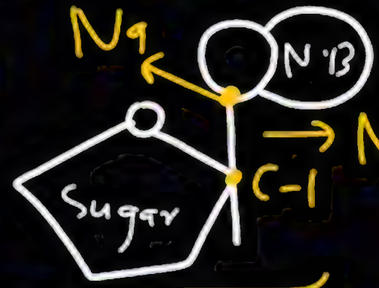


Purine

N_1 Pyrimidine

Sugar–C-1 → Purine – N_9
→ Pyrimidin → N_1

⇒



→ N-Glycosidic linkage

Nucleoside

Sugar	N·B	Nucleoside (N-Glycosidic)
Ribose	Adenine	Adenosine (C_1–N_9)
Ribose	Guanine	Guanosine
Ribose	Uracil	Uridine (C_1–N_1)
Ribose	Cytosine	Cytidine

note – Ribose not link with thymine
Deoxyribose not link with Uracil

Sugar	N·B	Nucleoside
Deoxyribose +	Adenine	→ deoxy Adenosine
Deoxyribos +	Guanine	– deoxy Guanosine
Deoxyribos +	Thymine	→ deoxy thymidine
DeoxyRibse +	Cytosine	→ deoxy Cytidine

Q Few Ex- Adenosine, Uridine, Thymine, deoxyguanosine, deoxycytidine, Cytosine

How many have N-Glycosidic linkage

(a) two (b) three ~~(c) Four~~ (d) Five

$N_1 - C_1$ Glycosidic → **Two**

Q Which have highest M.W

~~(a)~~ Adenosine → Ring + A Sugar + purine (Ribose)

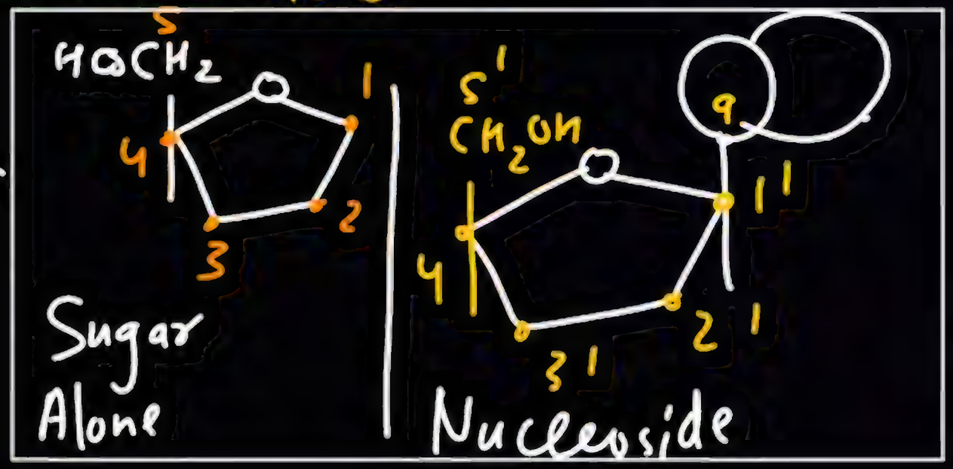
(b) deoxyAdenosine → Deoxy + A Sugar + purine

(c) Uridine → Ring + U (single ring)

(d) Guanine → N·B

Nucleotide = Nucleoside + Phosphate

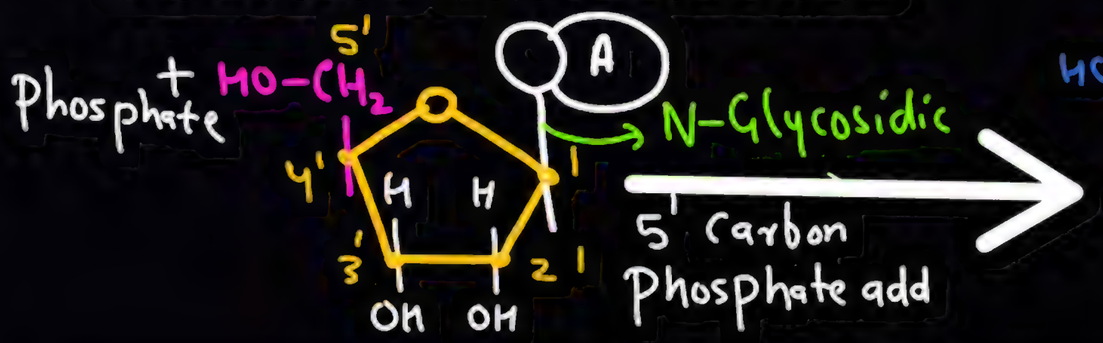
(Sugar + N·B) (Attach at 5' of Sugar)

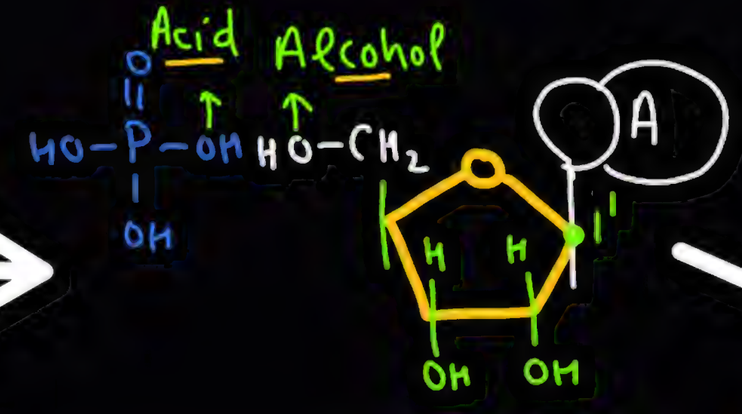


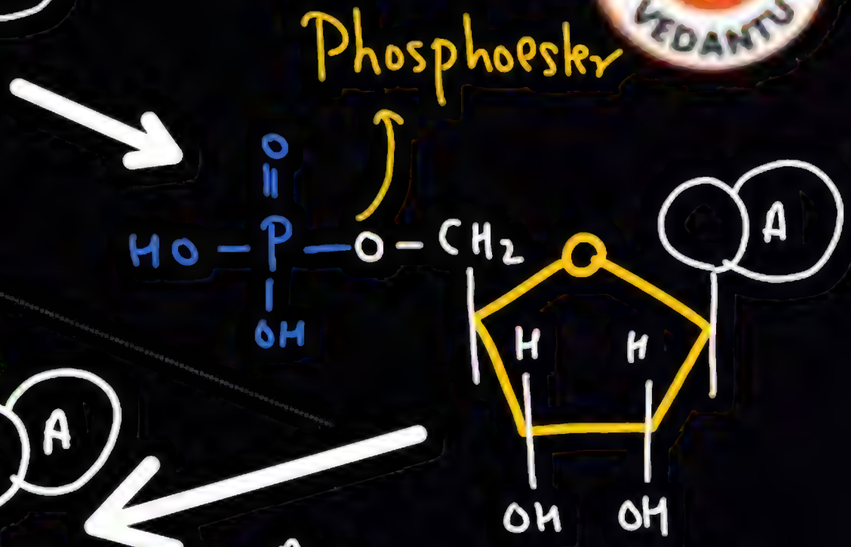
Q 5'-OH Group present on

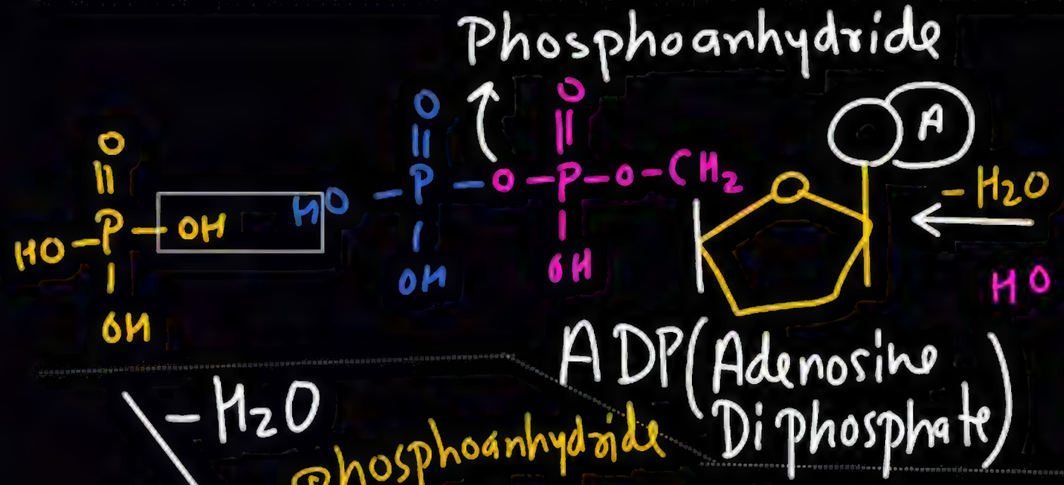
(a) Ribose (b) Deoxyribose ~~(c) Adenosine~~ (Nucleoside) (d) Guanine N·B

Structure of Nucleotide

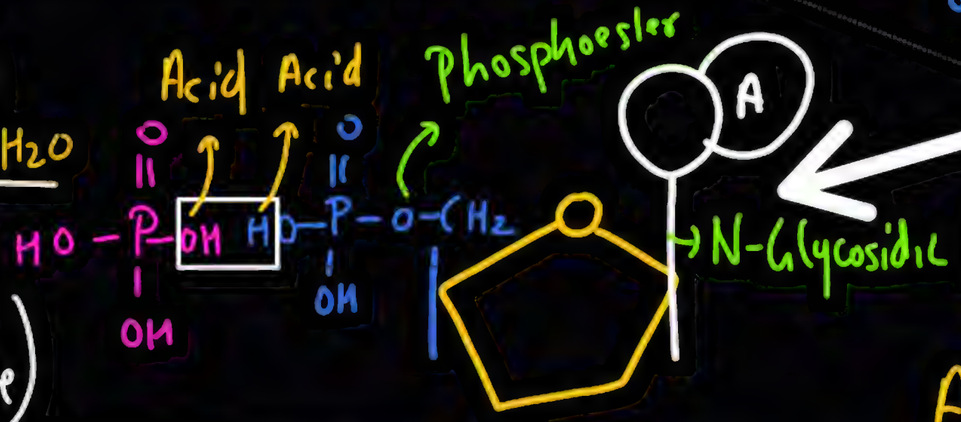








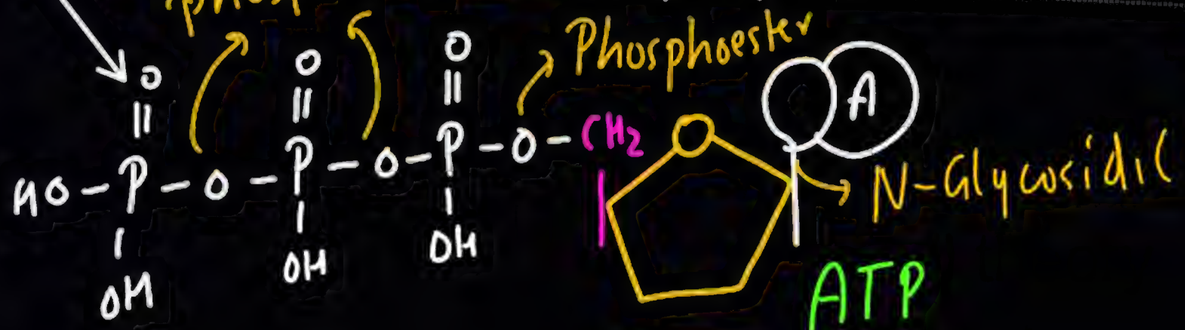
ADP (Adenosine Diphosphate)



Adenosine mono Phosphate)

AMP = nucleotide

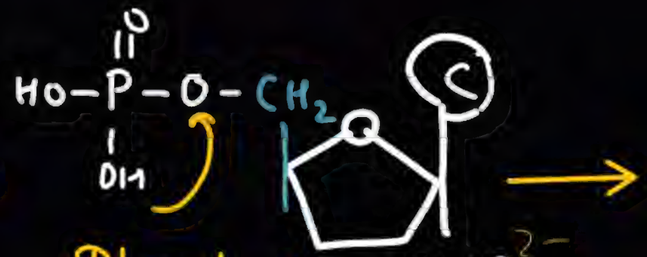
-H2O



ATP

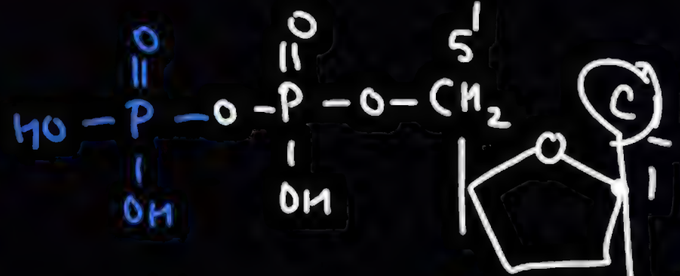
note - ATP, AMP, ADP - nucleotide

Nucleoside



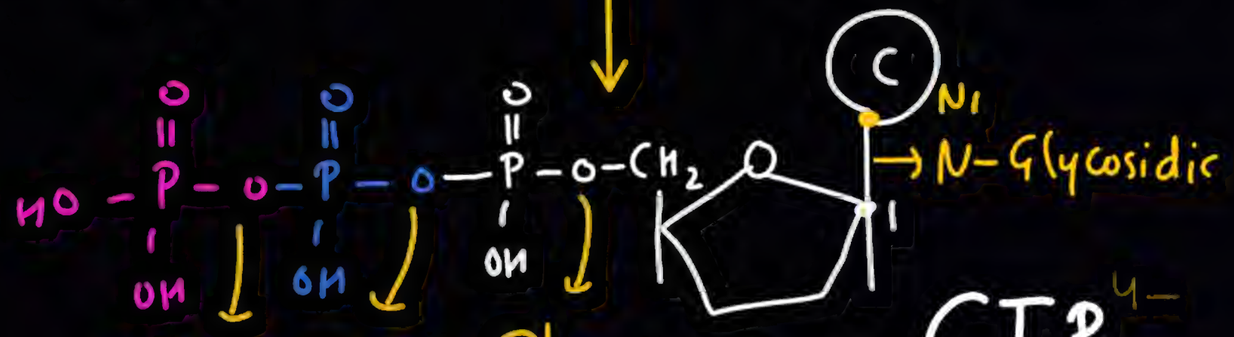
Phosphoester

CMP^{2-} (Cytidine mono phosphate)



CDP^{3-}

GTP = ATP



Phospho Anhydride

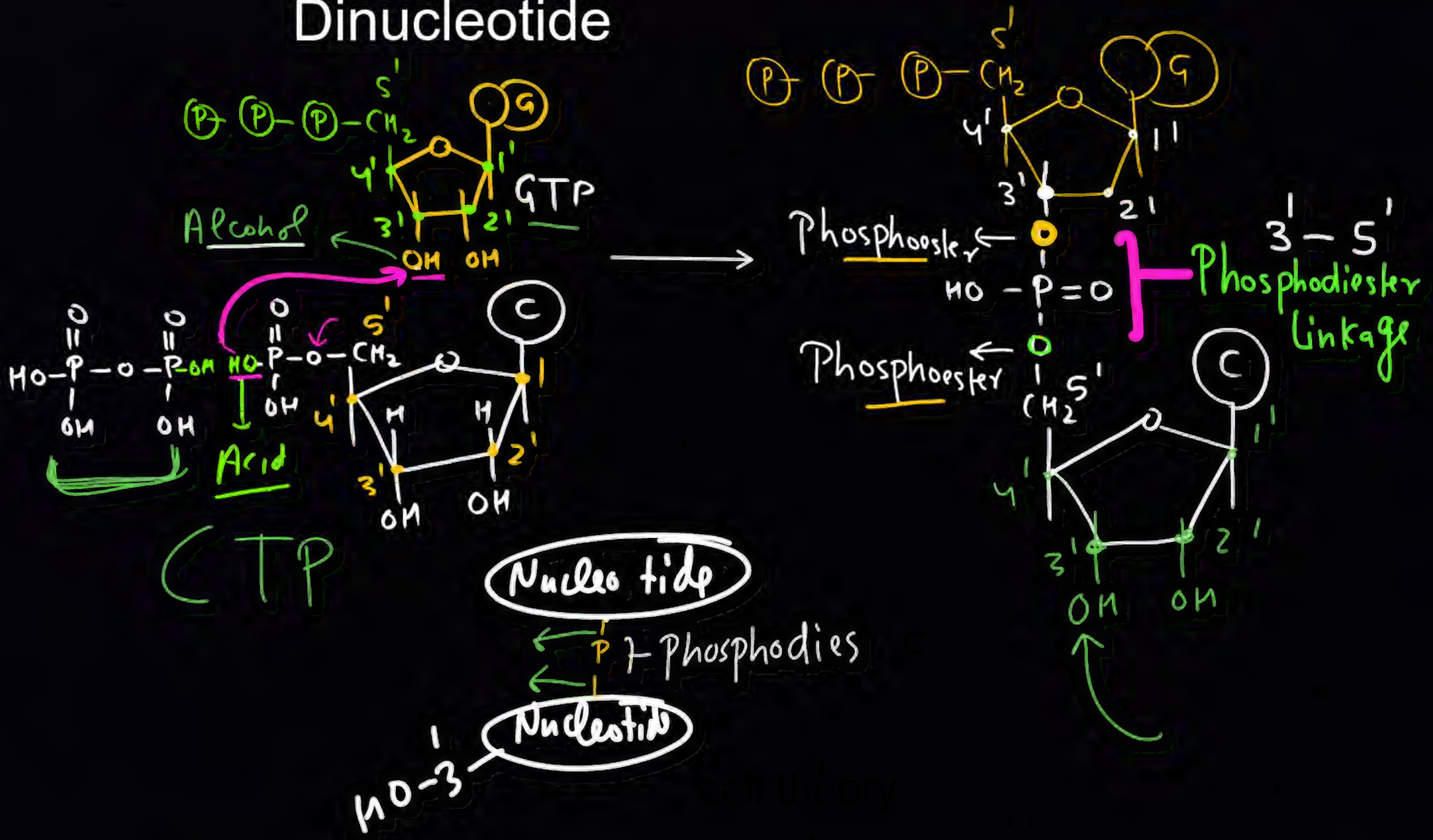
Phosphoester

CTP^{4-}

→ N-Glycosidic

Q Draw structure of CDP, dATMP, TTP, UDP

Dinucleotide



Q1 Phosphodiester linkage present in
(a) Dinucleotide (b) DNA (c) RNA (d) all

Q2 ATP and ADP Differ in
(a) N-Glycosidic (b) Phosphoester (c) Phosphoanhydride (d) all

Q3 Phosphoester Bond Absent in
(a) Dinucleotide (b) Adenosine (c) Polynucleotide (d) GTP

Q4 Adenosine & deoxy Adenosine Differ in
(a) Purine (b) N-Glycosidic (c) Oxygen (d) all

Q5 Cytidine & Uridine Differ in
(a) Sugar (b) Bond B/w Sugar & N·B (c) N·B (d) all

Q6 Charge on GMP is ____ negative
(a) one (b) two (c) three (d) Four

Q7 Not part of DNA
(a) UTP (b) deoxyribose (c) N-Glycosidic (d) Phosphoester

Q8 Phosphoester Bond B/w Sugar of Nucleoside and ____ form in Mononucleotide
(a) two Phosphate (b) one phosphate (c) three phosphate (d) all

Q9 Dinucleotide and Mononucleotide differ in
(a) Sugar (b) N-Glycosidic (c) Phosphodiester (d) Phosphoester

Q10 Second nucleotide Form ____ Bond with ____ carbon of First nucleotide
(a) Phosphoester, 3' (b) Phosphodiester, 3' (c) Phosphodiester, 5' (d) all

Q11 Which not have N-Glycosidic
(a) Cytosine (b) CDP (c) TTP (d) all

Q12 Not part of DNA
(a) Ribose (b) Uridine (c) UTP (d) all

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Biomolecule

lecture - 8

Botany

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Carbohydrate

Ex- Starch, Cellulose, Glycogen, Inulin, Glycocalyx, Agar, Ribose, Deoxyribose
Glucose, Fructose, Maltose, Sucrose, Lactose, Galactose, Chitin, Peptidoglycan
Ribulose, PGAL, DiHAP, Manose, Raffinose

Definition:- They are Hydrates (H_2O) of Carbon ⟶ (Old Definition)

Ex- Glucose → $C_6H_{12}O_6$

$C_n(H_2O)_n$

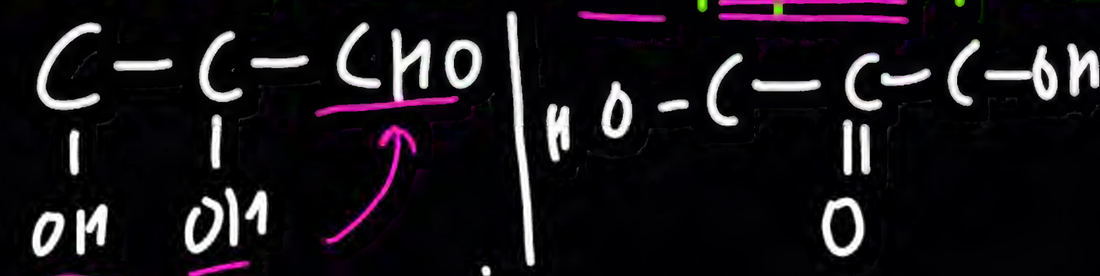
Carbon — Hydrate

(Old)

Some Compound → CH_3COOH — Follow Definition → not Carbohydrate

$C_2(H_2O)_2$

New def- They are Compounds → Polyhydroxy Aldehyde or Ketone



Q Which is not common to all carbohydrate
(a) Organic (b) More than one C (c) Poly Hydroxy OH (d) Ketone

Q Which is present in all Carbohydrate
(a) Hydroxy (b) Ketone (c) Aldehyde (d) all

Classification of Carbohydrate [Carbohydrate → 2-OH Group + Ketone/Aldehyde → Minimum Carbon = 3]

(a) Number of Carbon → (3-7)

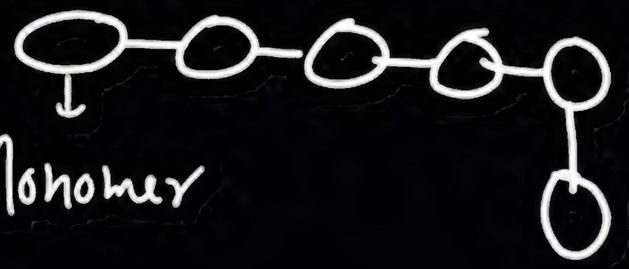
(i) 3C → Triose (Glycealdehyde or PGAL
Dihydroxy Arcetone or DiHAP)

(ii) 4C → Tetrose

(iii) 5C → Pentose → Ribose, Ribulose

(iv) 6C → Hexose

(v) 7C → Heptose



(2) Classifaction on the Basis of – Functional Group (Aldose / Ketose)

no. of Carbon	Aldose	Ketose
3C	PGAL	DiHAP (3C)
4C	Erythrose X	Erthrulose X
5C	– Ribose Deoxyribose	Ribulose (5C) (RUBP)
6C →	Glucose Galactose	Fructose (6C)
7C →		Sedoheptulose

Q Which is Ketose

(a) Ribose (b) Deoxyribose

(c) Fructose (d) alp

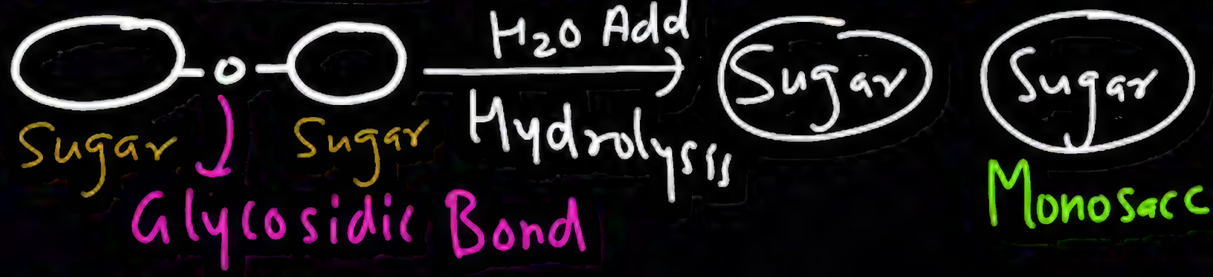
Q Which is not true About Sugar of nucleic Acid (DNA or RNA)

(a) Aldose (b) 5C (c) Ketose (d) Ring Compound

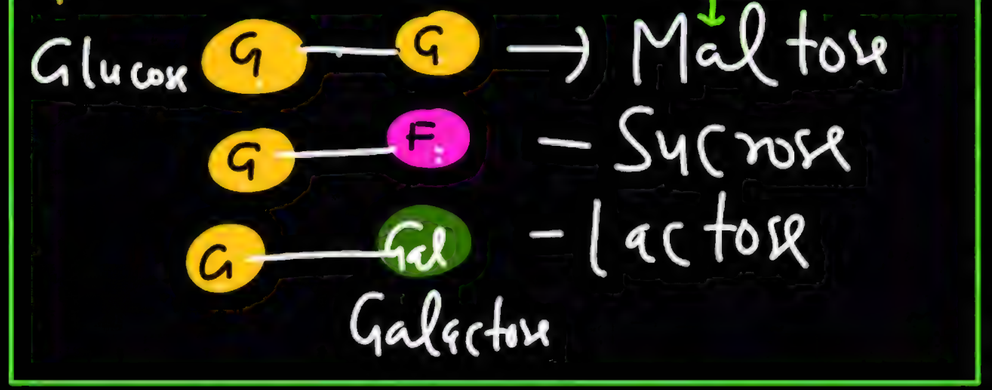
(3) On the Basis of no. of Units produce By Hydrolysis

(a) Mono saccharide (One Sugar) ⟶ not hydrolysed Further
Ex- Glucose, Fructose, Galactose, Ribose, Deoxyribose

(b) Dia saccharide ⟶ On hydrolysis two Sugar | two unit



Example of Dia saccharide

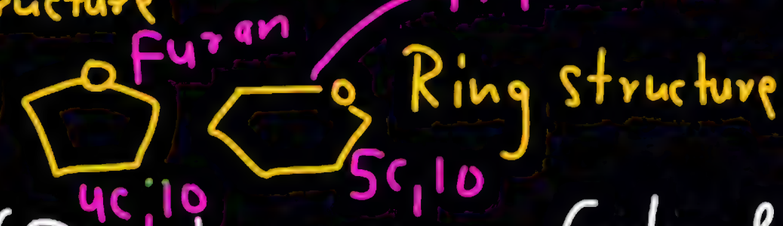


(c) Polysaccharide → On hydrolysis → n number of Monosaccharide
↳ n-1 → Glycosidic Bond Break
Ex- Starch, Glycogen, Cellulose

Structures of Carbohydrates

Carbohydrates → monosaccharide structure study → Two type of structure

(a) C-C-C-C-C-C
open chain

(b) 

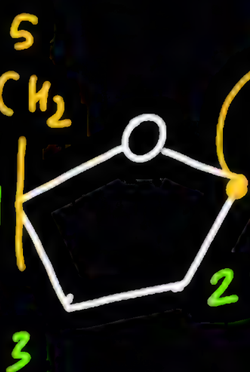
(Ring have oxygen – Carbonyl Compound

(a) C=C-C → open chain (always) — Triose
C-C-CHO

(b) Tetrose → open chain

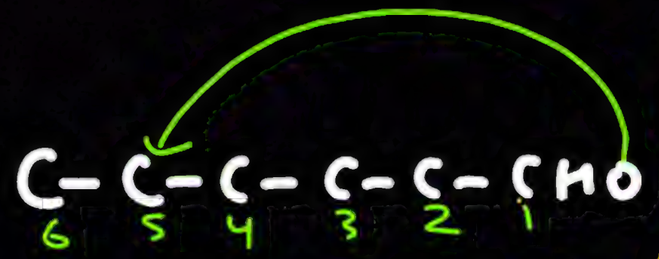
(c) Pentose → C=C-C-C=C-C (not Form Ring) — Ribulose

→ C-C-C-C-CHO (1 = CHO, 4 ← 3 ← 2 ← 1) — Ribose, Deoxyribose
(Ring)
(Aldose)

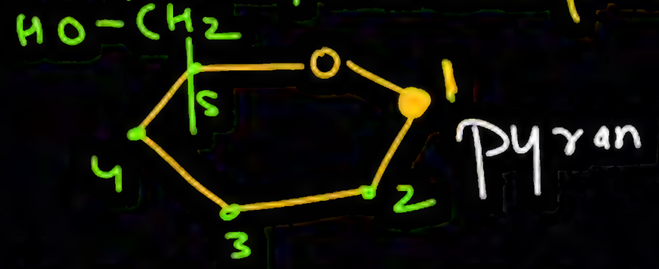


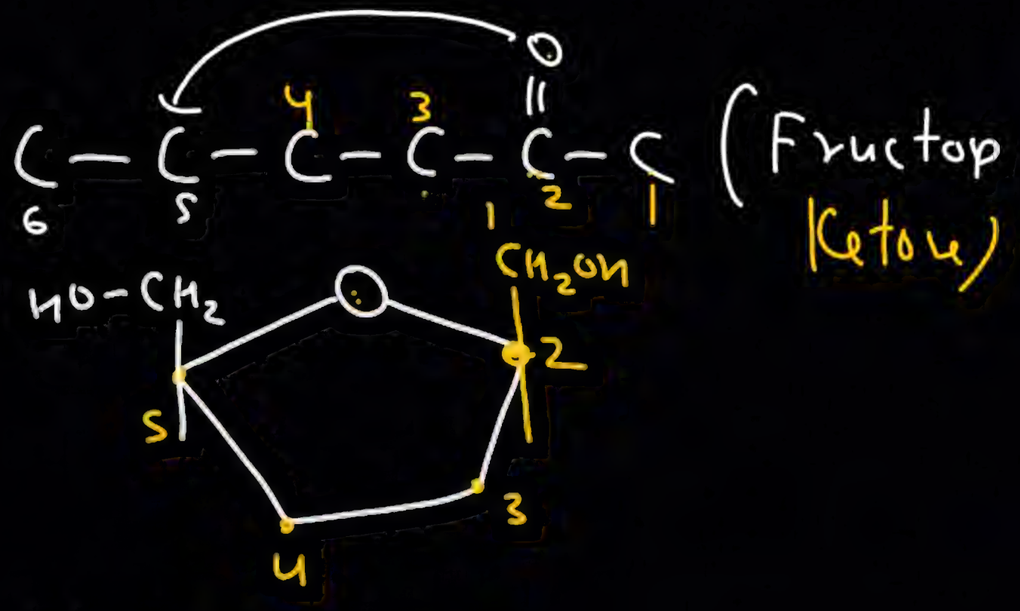
→ C-1 Carbonyl
(Furan)
Ring → 4C, 1O

(c) hexose → Glucose, Galactose
Fructose



Glucose, Galactose (Aldose)

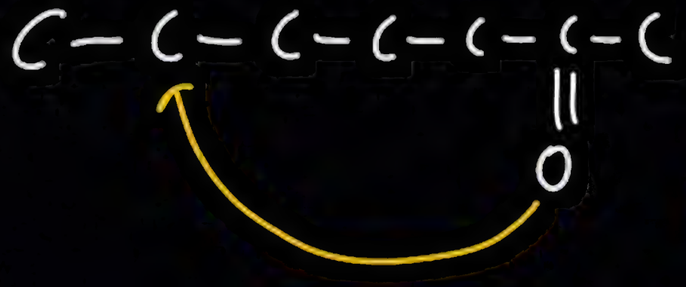


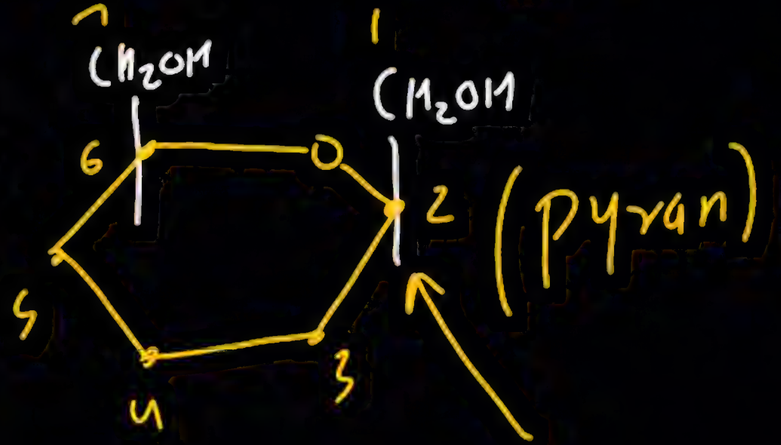


Q Which Compound have Carbonyl carbon at C-1

(a) Glucose (b) Galactose (c) Fructose (d) Both a & b

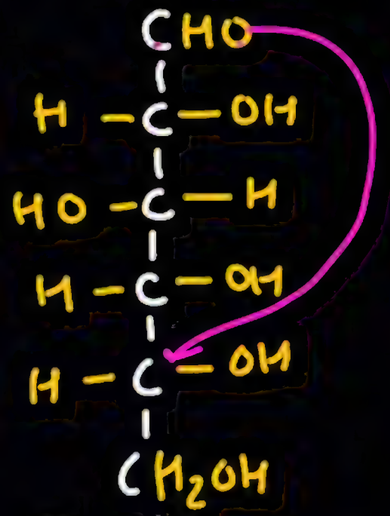
Sedoheptulose



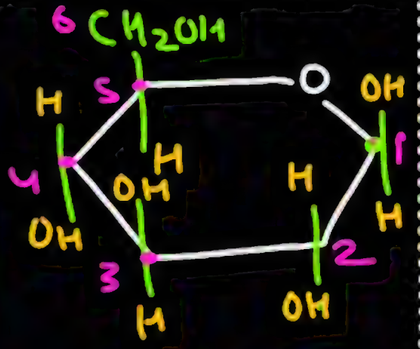


Important structure – Most Monosaccharide dextrorotatory, Optically inactive → Dihydroxy acetone

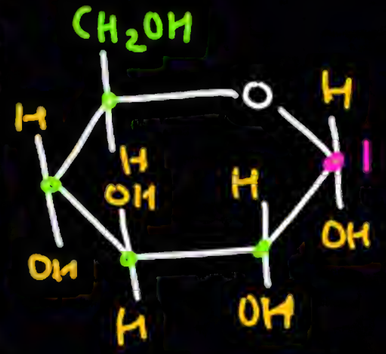
(a) Glucose → 6C → $C_6H_{12}O_6$



D-Glucose (open chain)



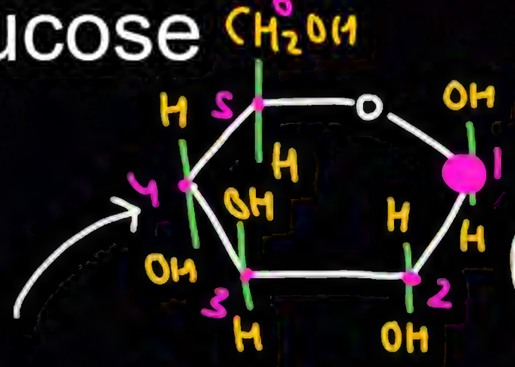
β-D Glucose (Along trend)



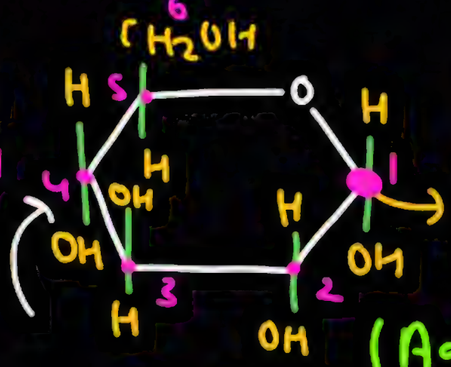
α-D Glucose (Against trend)

Differ at C-1 (Carbonyl carbon)

Glucose



β-D Glucose

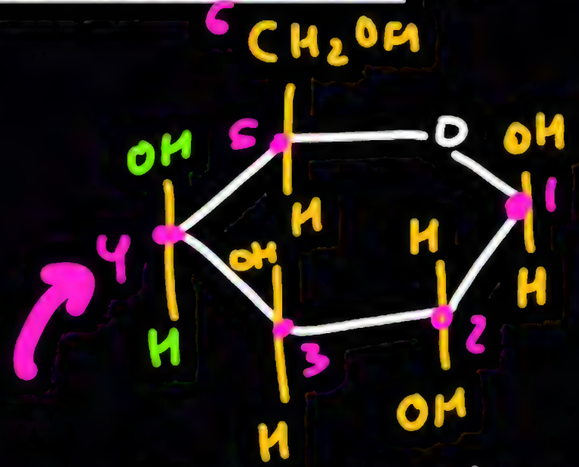


α-D Glucose

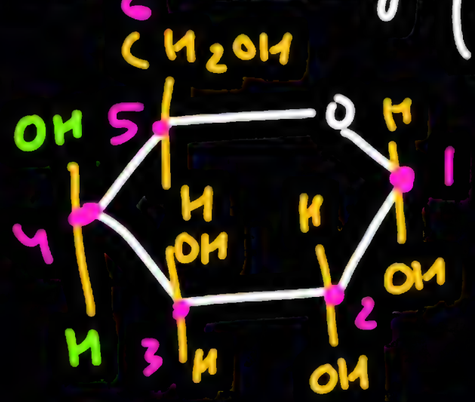
Carbonyl Carbon → Anomeric Carbon

(Against trend)

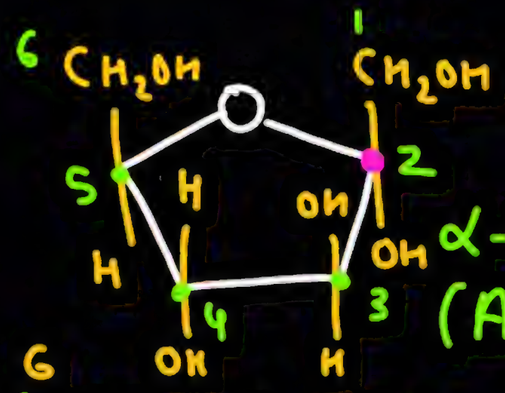
Galactose — β-D Glucose → Change at C-4 (β-D Galactose Form)



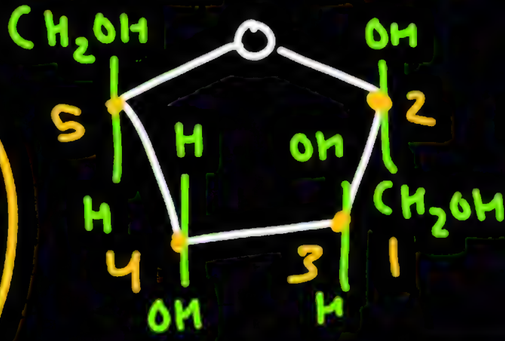
β-D Galactose



α-D-Galactose



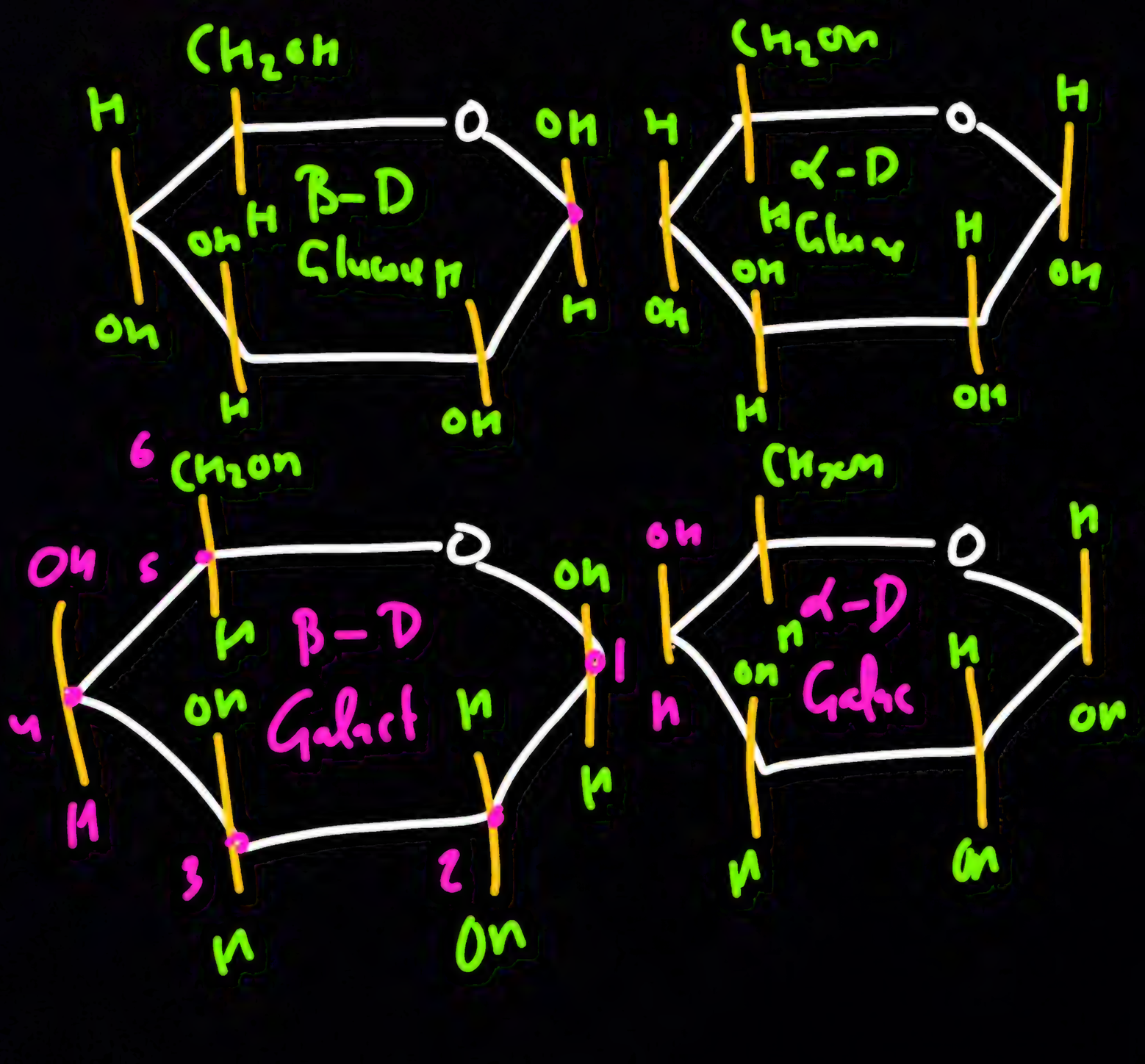
α-D Fructose (Along trend)



β-D Fructose (Against trend)

Q α-D Glucose & α-D Galactose Differ in

(a) Ring (b) C-1 Carbon (Anomeric Carbon) ~~(c) C-4~~ (d) ab


β-D Glucose
α-D Glucose
β-D Galact
α-D Galac

Glucose & Fructose (Isomers)

α-D Glucose ⇌ β-D-Glucose [Difference at C-1 (Anomeric/Carbonyl Carbon)]

Anomers

C-4 Diff. Epimers

α-D Galactose ⇌ β-D Galactose (Different at C-1 Anomeric Carbon)

Anomers ✓

α-D Fructose ⇌ β-D Fructose (Different at C-2 Anomeric Carbon is C-2)

Anomers

Q Which pair is not Anomers

(a) α-D Glu β-D Glu

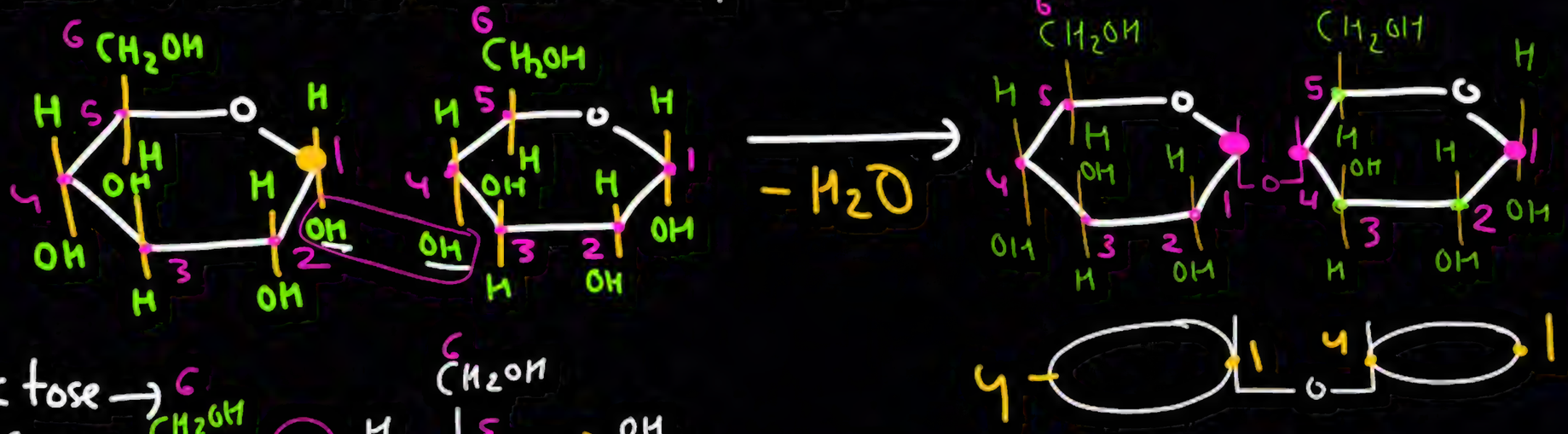
(b) α-D Galac β-D Galac

(c) α-D Fru β-D Fru

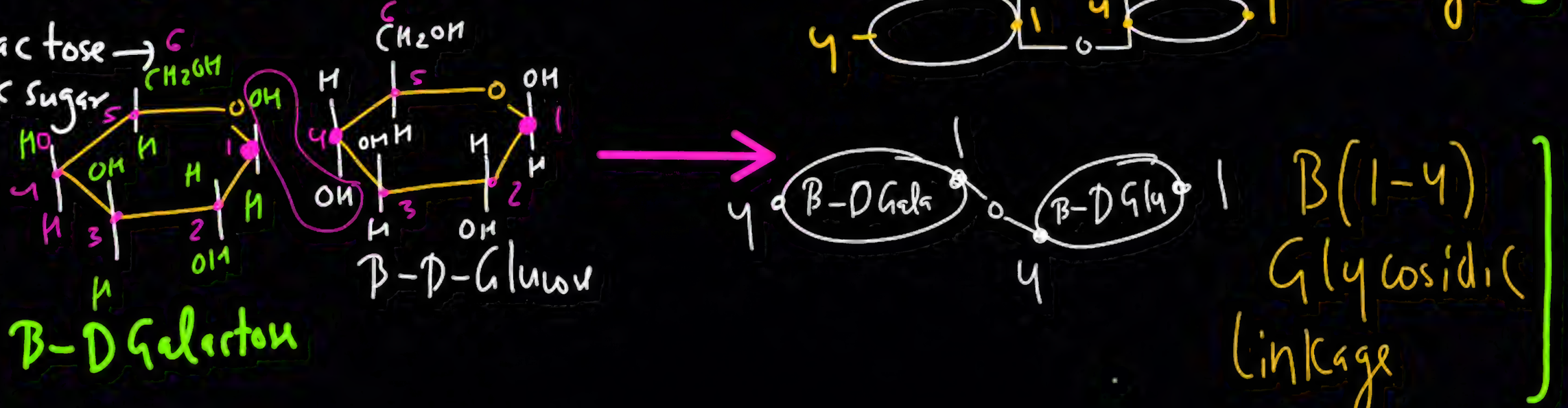
(d) α-D Glu α-D-Galac (Epimers)

Diasaccharides

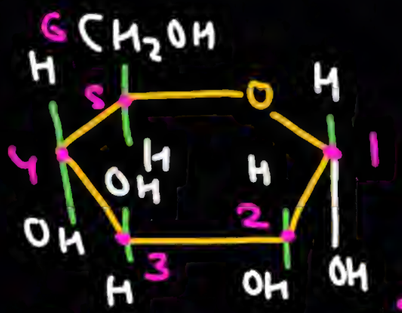
(a) Maltose → two α-D Glucose link By Glycosidic Bond



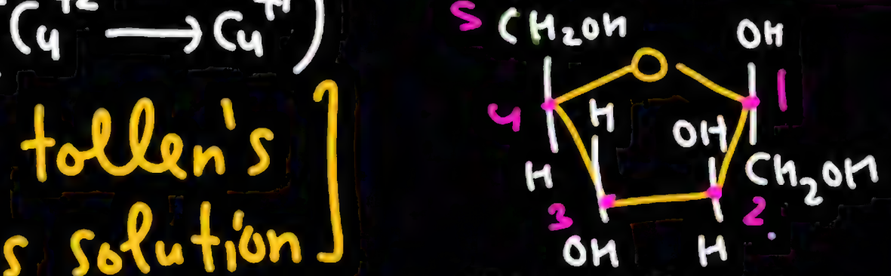
(b) lactose → (Milk sugar)



(3) Sucrose → Glucose & Fructose link



α-D Glucose



β-D Fructose

$(Cu^{+2} \longrightarrow Cu^{+1})$

Reducing Sugar → Reduce tollen's & Fehling's solution

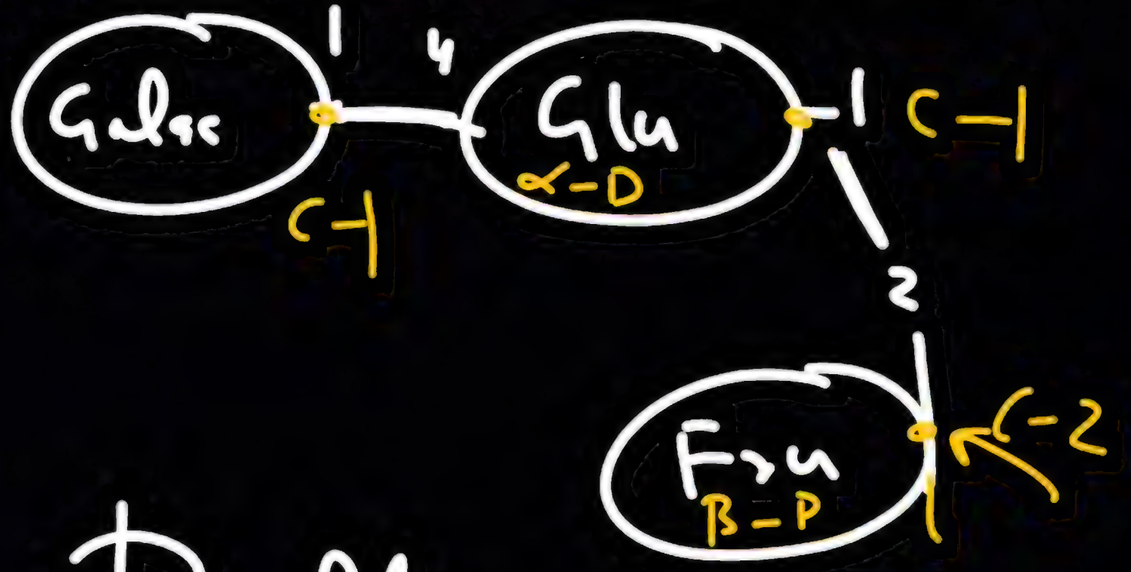
$(Ag^{+} \rightarrow Ag)$

Condition → Free Carbonyl Group (not Form Bond)

Glucose, Fructose, Galactose – Monosaccharide – Reducing

Maltose, Lactose – Reducing

Sucrose – non-Reducing → Glucose – C-1, Fructose → C-2 – Bond Formation involve



Raffinose – Trisaccharide –

DOPA

Q1 DiHAP have no. of Carbon

(a) 3C (b) 2C (c) 4C (d) 5C

Q2 Ribulose is all Except

(a) Mono Saccharide (b) Ketose (c) Aldose (d) Pentose

Q3 Glucose and Fructose Differ in

(a) Carbon (b) OH Group number (c) type of Carbonyl (d) Both b & c

Q4 Number of Carbon in Disaccharide like Lactose

(a) 12C (b) 6C (c) 18C (d) all

Q5 Bond in maltose is

(a) β(1-4) (b) α(1-1) (c) α(1-4) (d) none

Q6 α-D Glucose & β-D Glucose Differ in

(a) C-1 (b) Anomeric Carbon (c) No. of Carbon (d) Both a & b

Q7 Which is not Reducing

(a) Glucose (b) Fructose (c) Sucrose (d) all

Q8 Sucrose is Disaccharid with

(a) Glu + Galac (b) α-D Glu + α-D-Fru (c) α-D Glu + β-D Galac (d) α-D Glu + β-D Fru

Q9 More than two Glycosidic Bond

(a) Maltose (b) Sucrose (c) Lactose (d) Raffinor

Q10 Which is Derive Sugar

(a) Ribose (b) Deoxyribose (c) Raffinose (d) Glucose

Q

MANTHAN NEET 2025 - 1.0 & 2.0

SANKALP NEET VEDANTU

Biomolecule

lecture - 11

Botany

TARUN SIR

Carbohydrate

Ex- Starch, Cellulose, Glycogen, Inulin, Glycocalyx, Agar, Ribose, Deoxyribose
Glucose, Fructose, Maltose, Sucrose, lactose, Galactose, Chitin, Peptidoglycan
Ribulose, PGAL, DiHAP, Manose, Raffinose

Definition:- They are Hydrates(H_2O) of Carbon ⟶ (Old Definition)

Ex- Glucose → $C_6H_{12}O_6$

$C_n(H_2O)_n$

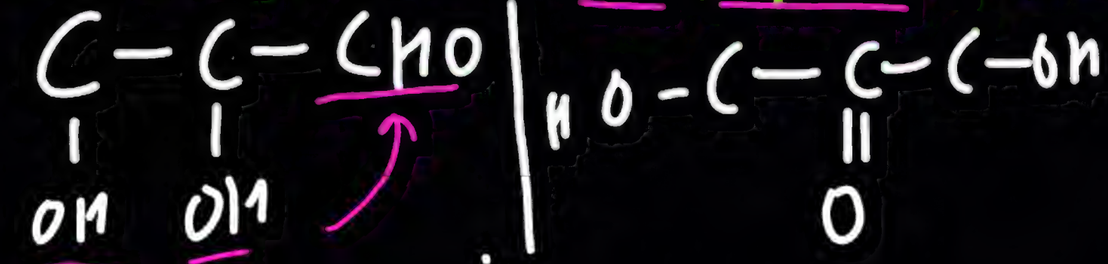
Carbon — Hydrate

(old)

Some Compound → CH_3COOH — Follow Definition → not Carbohydrate

$C_2(H_2O)_2$

New def- They are Compounds → Polyhydroxy Aldehyde or Ketone



Q Which is not common to all carbohydrate

(a) Organic (b) More than one C (c) Poly Hydroxy OH (d) Ketone

Q Which is present in all Carbohydrate

(a) Hydroxy (b) Ketone (c) Aldehyde (d) all

Classification of Carbohydrate [Carbohydrate → 2-OH Group + Minimum Carbon = 3 + Ketone | Aldehyde]

(a) Number of Carbon → (3-7)

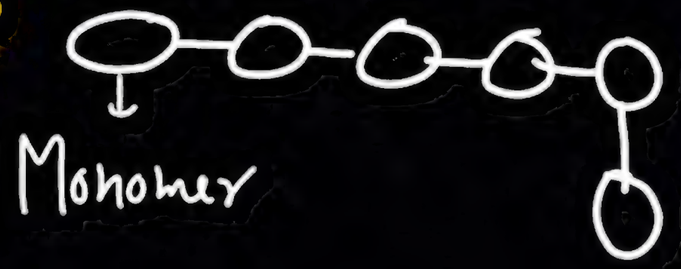
(i) 3C → Triose (Glycealdehyde or Dihydroxy Acetone) PGAL or DiHAP

(ii) 4C → Tetrose

(iii) 5C → Pentose → Ribose, Ribulose

(iv) 6C → Hexose

(v) 7C → Heptose



(2) Classification on the Basis of — Functional Group (Aldose / Ketose)

no. of Carbon	Aldose	Ketose
3C	PGAL	DiHAP (3C)
4C	Erythrose ✗	Erthrulose ✗
5C	Ribose, Deoxyribose	Ribulose (5C) (RUBP)
6C →	Glucose, Galactose	Fructose (6C)
7C →		Sedoheptulose

Q Which is Ketose
(a) Ribose (b) Deoxyribose
(c) Fructose (d) alp

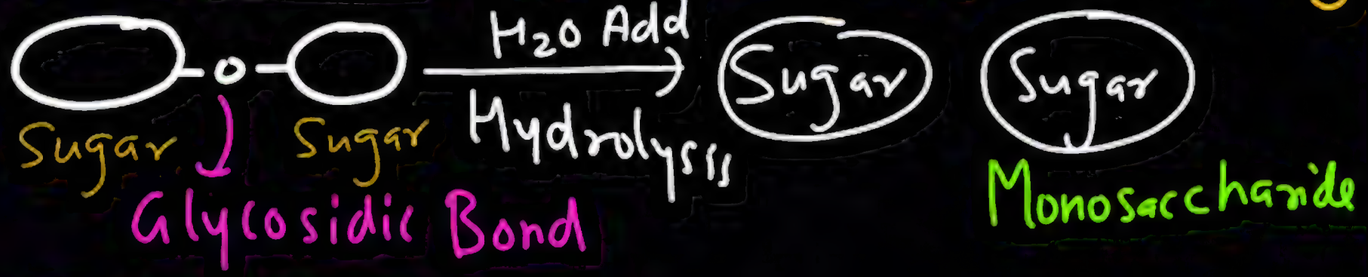
Q Which is not true About Sugar of nucleic Acid (DNA or RNA)
(a) Aldose (b) 5C (c) Ketose (d) Ring Compound

(3) On the Basis of no. of Units produce By Hydrolysis

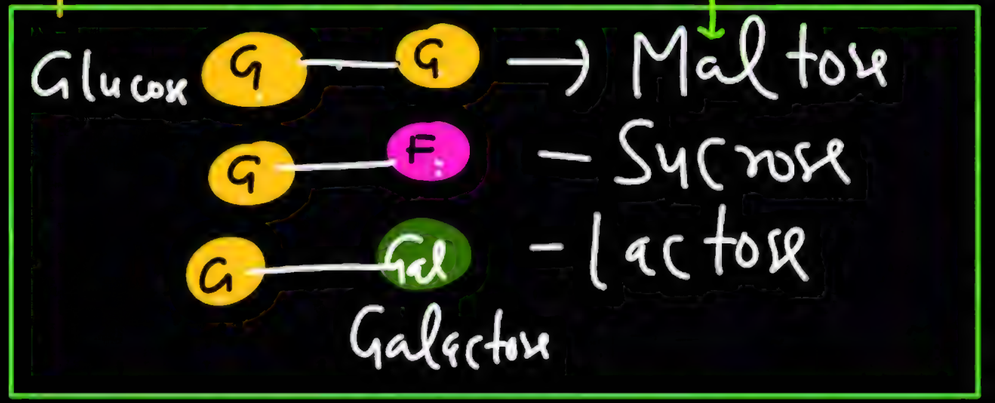
(a) Mono saccharide (One Sugar) ⟶ not hydrolysed Further

Ex- Glucose, Fructose, Galactose, Ribose, Deoxyribose

(b) Dia saccharide ⟶ On hydrolysis two Sugar | two unit



Example of Dia saccharide



(c) Polysaccharide → On hydrolysis → n number of Monosaccharide

↳ n-1 → Glycosidic Bond Break

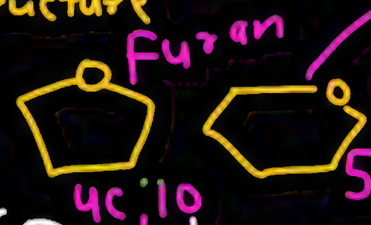
Ex- Starch, Glycogen, Cellulose

Structures of Carbohydrates

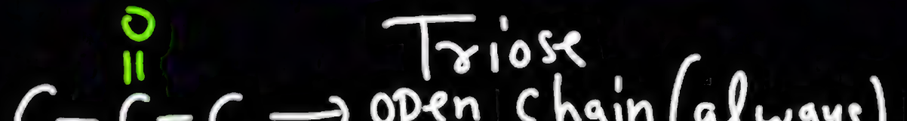
Carbohydrates → monosaccharide structure study → Two type of structure

(a) C–C–C–C–C–C
open chain

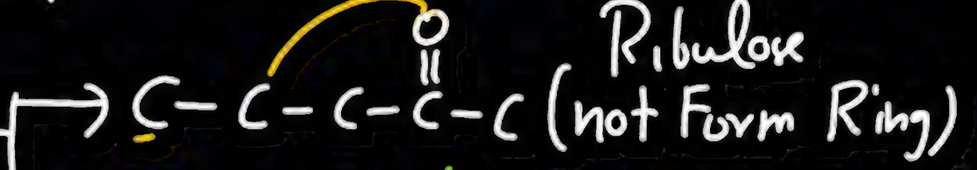
(b) Ring structure

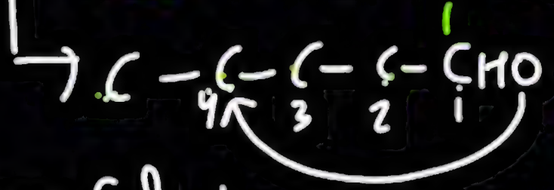


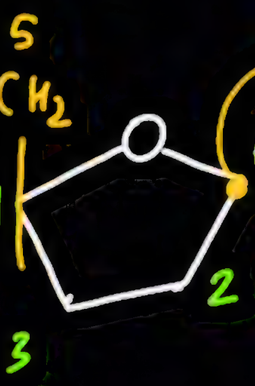
(Ring have oxygen – Carbonyl Compound

(a)  → Triose → open chain (always)
C–C–CHO

(b) Tetrose → open chain

(c) Pentose →  → Ribulose (not Form Ring)

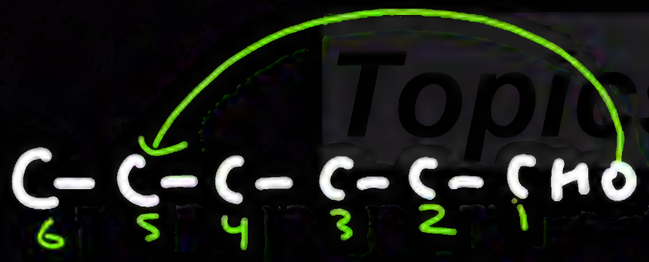
→  – Ribose, Deoxyribose
(Ring)
(Aldose)



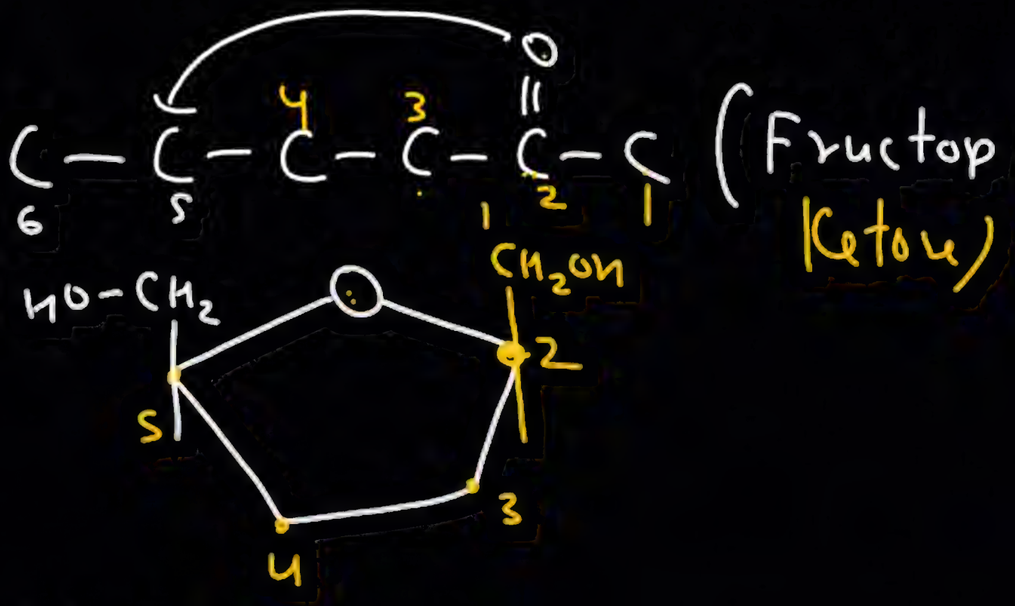
→ C-1 Carbonyl
(Furan)
Ring → 4C, 1O

(d) hexose → Glucose, Galactose
Fructose

Topics



Glucose, Galactose (Aldose)

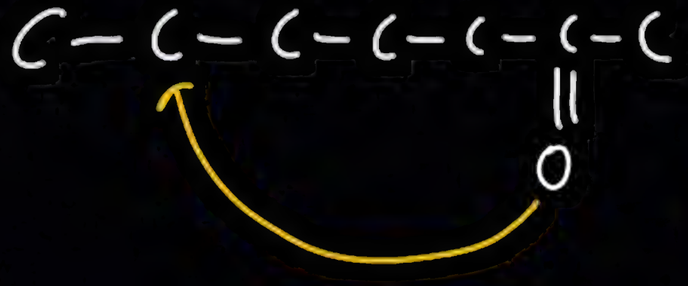


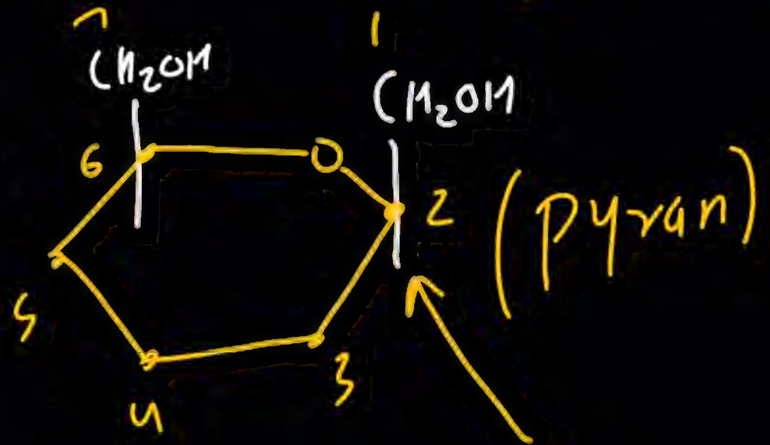
(Fructop Ketose)

Q Which Compound have Carbonyl carbon at C-1

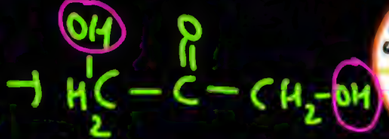
(a) Glucose (b) Galactose (c) Fructose (d) Both a & b

Sedoheptulose



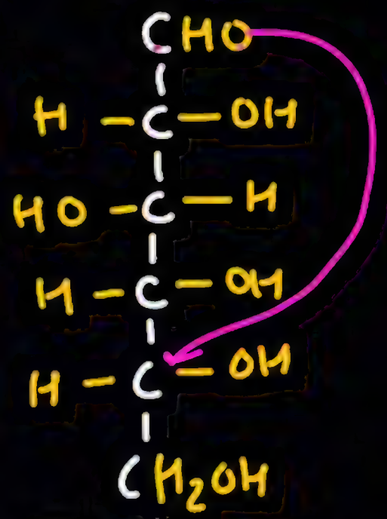


Important structure

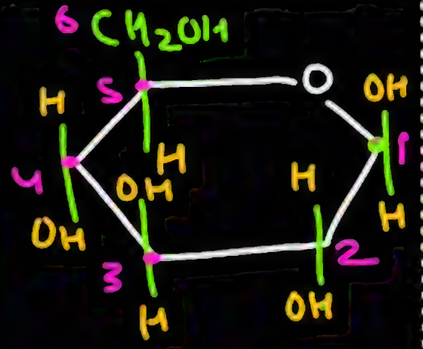
– Most Monosaccharide dextrorotatory, Optically Inactive → 

Dihydroxy acetone

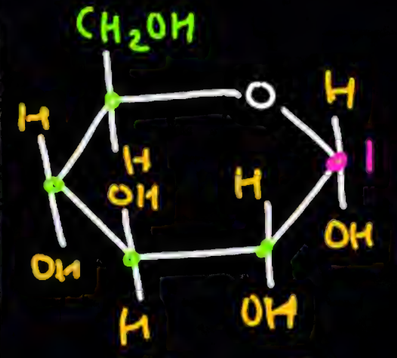
(a) Glucose → 6C → $C_6H_{12}O_6$



D-Glucose (open chain)



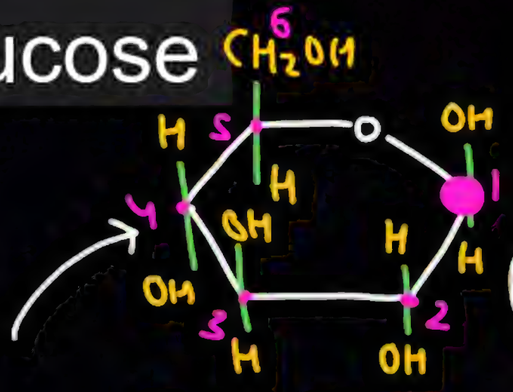
β-D Glucose (Along trend)



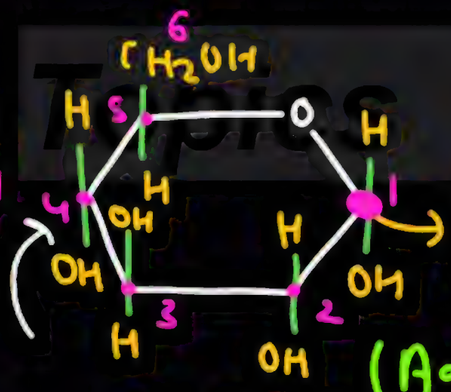
α-D Glucose (Against trend)

Differ at C-1 (Carbonyl carbon)

Glucose



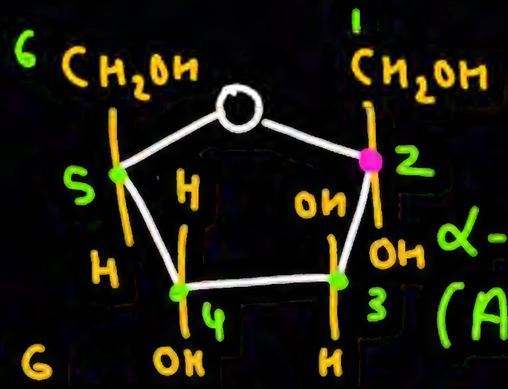
β-D Glucose



α-D Glucose

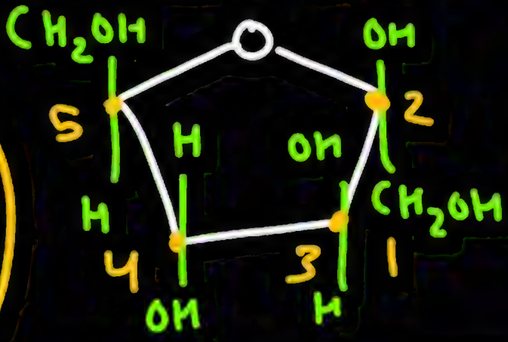
Carbonyl Carbon → Anomeric Carbon

(Against trend)



α-D Fructose

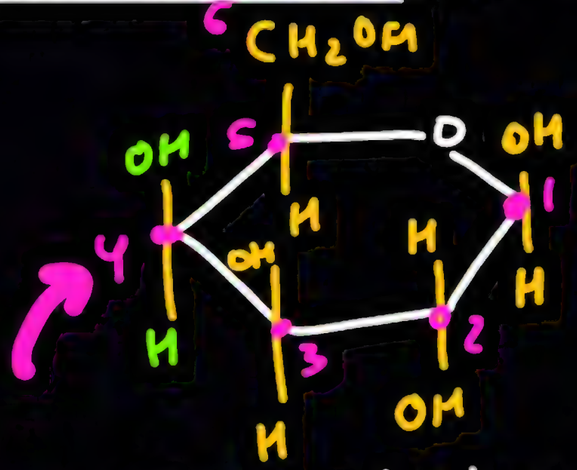
(Along trend)



β-D Fructose

(Against trend)

Galactose — β-D Glucose → Change at C-4 → (β-D Galactose Form)

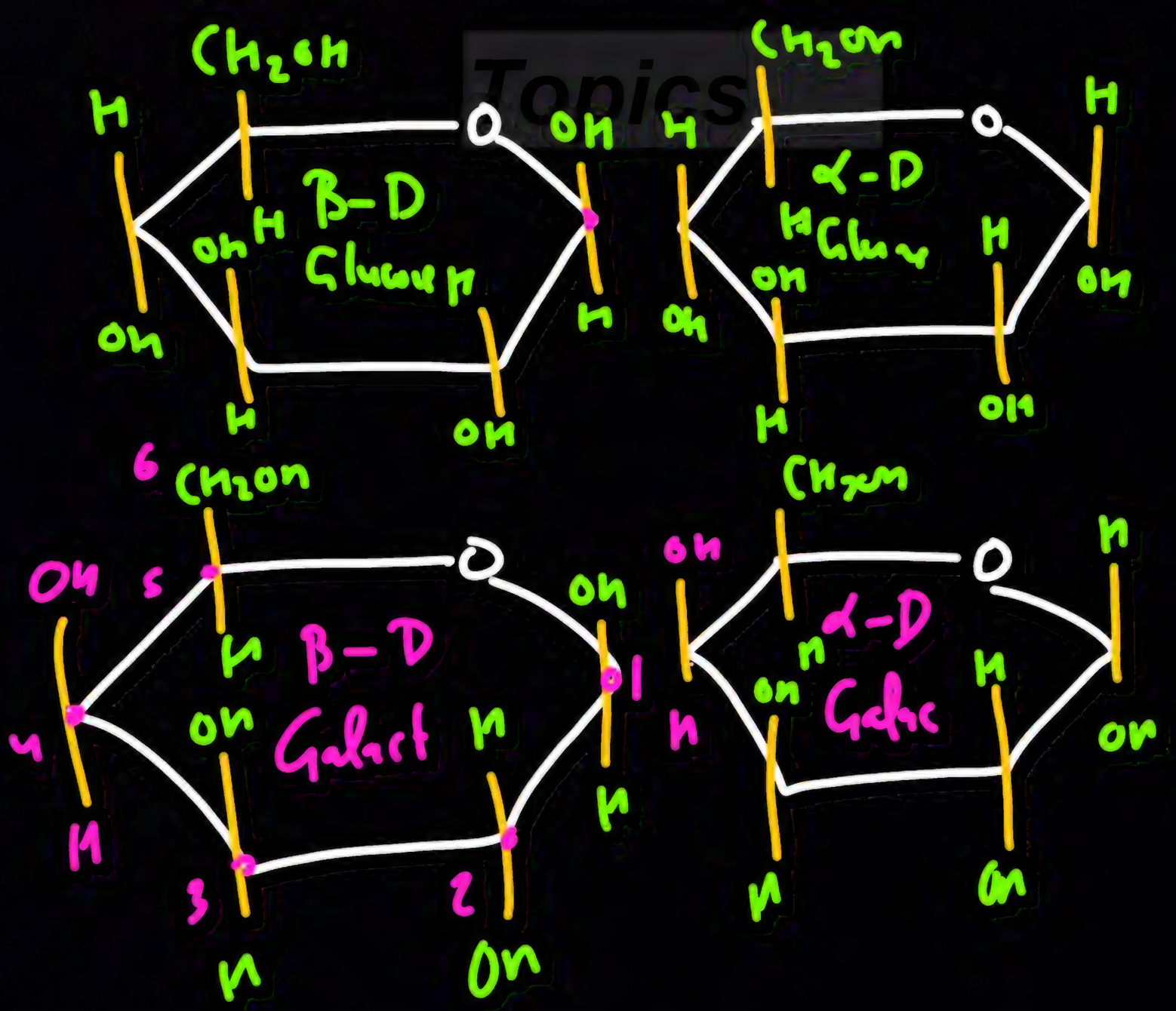


β-D Galactose

α-D-Galactose

Q α-D Glucose & α-D Galactose Differ in

(a) Ring (b) C-1 Carbon (Anomeric Carbon) ~~(c) C-4~~ (d) all


CH2OH
H
OH
H
OH
H
OH
β-D
Glucose
CH2OH
H
OH
H
OH
H
OH
α-D
Glucose
6
CH2OH
OH
5
H
OH
H
OH
4
H
3
H
2
OH
1
β-D
Galact
CH2OH
OH
H
OH
H
OH
H
α-D
Galac
H
OH

Topics

Glucose & Fructose (Isomers)

α-D Glucose ⇌ β-D-Glucose — Anomers — [Difference at C-1 (Anomeric / Carbonyl Carbon)]

α-D Galactose ⇌ β-D Galactose — Anomers ✓ — (Different at C-1 Anomeric Carbon)

α-D Fructose ⇌ β-D Fructose — Anomers — (Different at C-2 Anomeric Carbon is C-2)

[C-4 Different Epimers]

Q Which pair is not Anomers

(a) α-D Glu β-D Glu

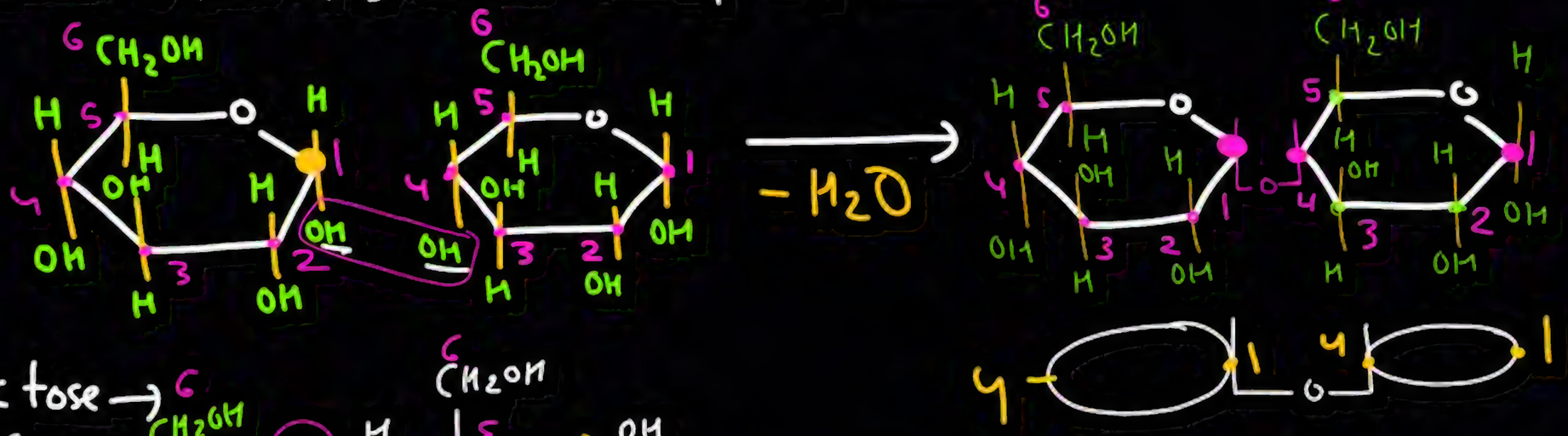
(b) α-D Galac β-D Galac

(c) α-D Fru β-D Fru

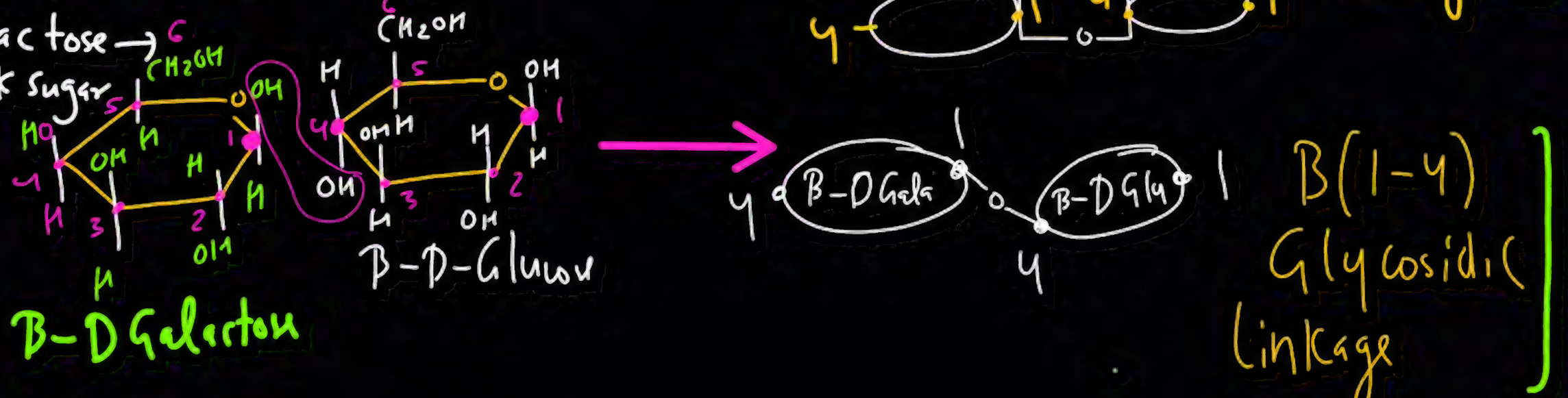
(d) α-D Glu α-D-Galac (Epimers)

Diasaccharides

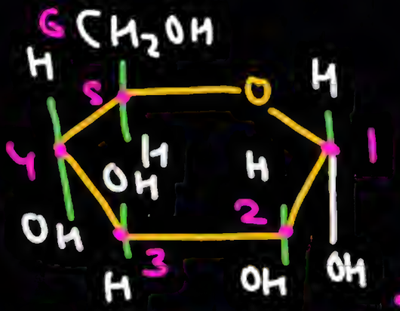
(a) Maltose → two α-D Glucose link By Glycosidic Bond



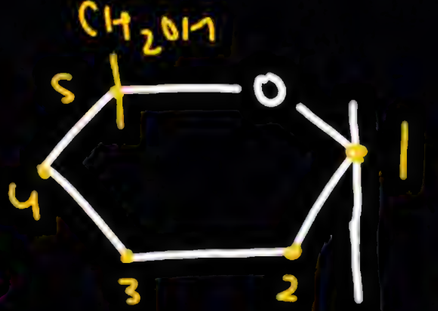
(b) lactose → (Milk sugar)



(3) Sucrose → Glucose & Fructose link



α-D Glucose

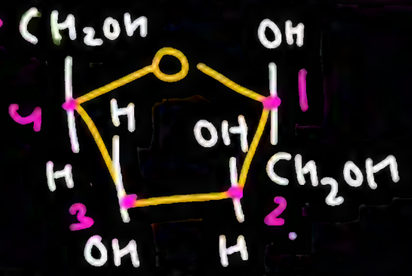


1-2 Glycosidic

$(Cu^{+2} \longrightarrow Cu^{+1})$

Reducing Sugar → Reduce tollen's & Fehling's solution

$(Ag^{+} \rightarrow Ag)$



β-D Fructose

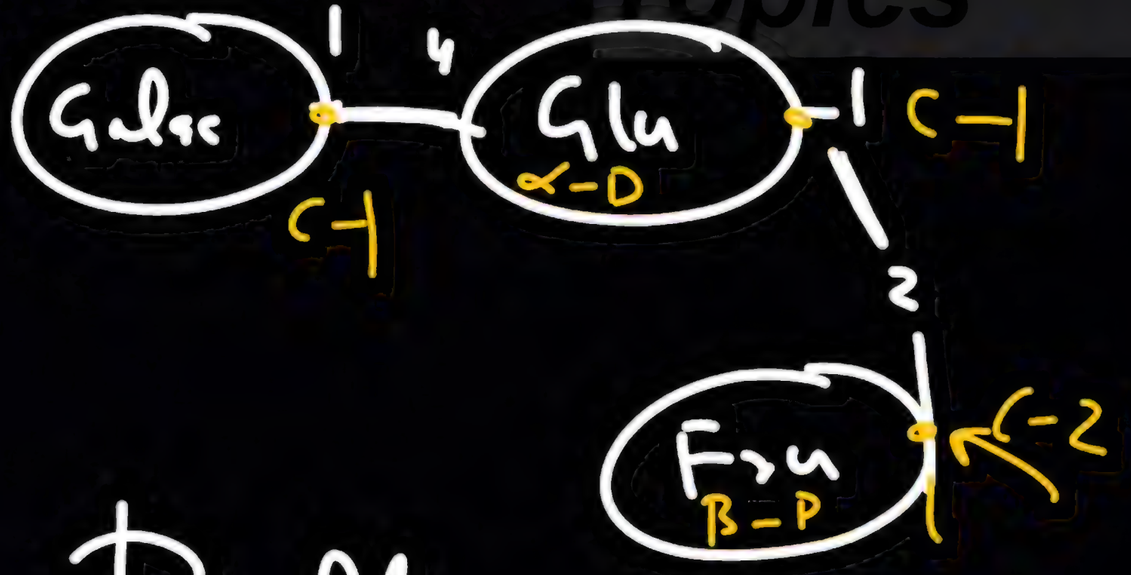
Condition → Free Carbonyl Group (not Form Bond)

Glucose, Fructose, Galactose – Monosaccharide – Reducing

Maltose, Lactose – Reducing

Sucrose – non-Reducing ⟶ Glucose – C-1, Fructose → C-2 – Bond Formation involve

Topics



Raffinose – Trisaccharide –

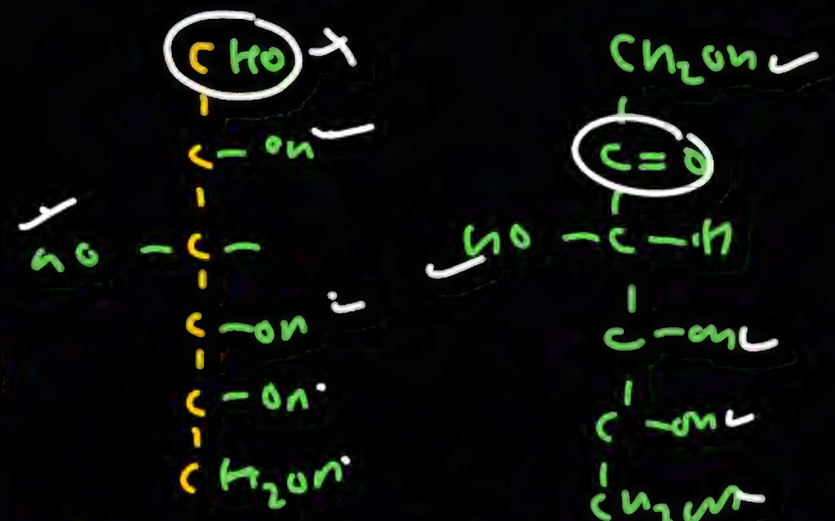
DOPA

Q1 DiHAP have no. of Carbon

(a) 3C (b) 2C (c) 4C (d) 5C

Q2 Ribulose is all Except

(a) Mono Saccharide (b) Ketose (c) Aldose (d) Pentose



Q3 Glucose and Fructose Differ in

(a) Carbon (b) OH Group number (c) type of Carbonyl (d) Both b & c

Q4 Number of Carbon in Disaccharide like Lactose

(a) 12C (b) 6C (c) 18C (d) all

Q5 Bond in maltose is

(a) β(1-4) (b) α(1-1) (c) α(1-4) (d) none

Q6 α-D Glucose & β-D Glucose Differ in

(a) C-1 (b) Anomeric Carbon (c) No. of Carbon (d) Both a & b

Position of OH

Q7 Which is not Reducing

(a) Glucose (b) Fructose (c) Sucrose (d) all

Q8 Sucrose is Disaccharid with

(a) Glu + Galac (b) α-D Glu + α-D-Fru (c) α-D Glu + β-D Galac (d) α-D Glu + β-D Fru

Q9 More than one Glycosidic Bond

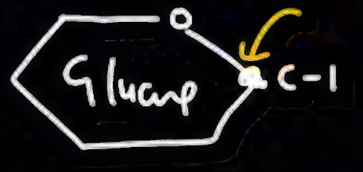
(a) Maltose (b) Sucrose (c) Lactose (d) Raffinose (2)

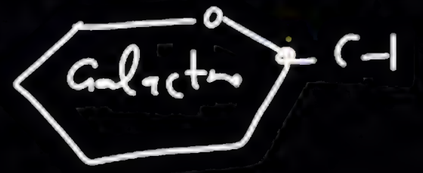
Q10 Which is Derive Sugar Ribose $\xrightarrow{O-less}$ Deoxyribose

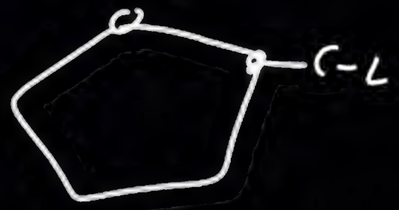
(a) Ribose (b) Deoxyribose (c) Raffinose (d) Glucose

Reducing and Non-Reducing

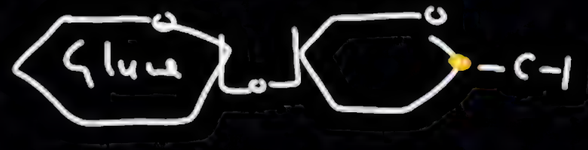
Q

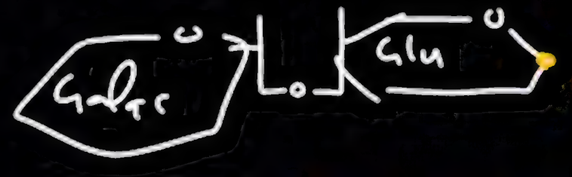




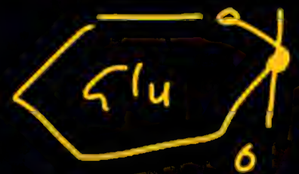


Maltose





Lactose



C-1 Anomer

C-2 – Anomeric

Ribose $\xrightarrow[\text{loss}]{\text{1 O}}$ Deoxyribose

Polysaccharide

→ n no. of monosaccharide unit

→ Bond → Glycosidic n−1 Bond

Type of polysaccharide

note- Polymer of Glucose – Glucan / Glycan
Polymer of Mannose – Mannan
Polymer of Galactose – Galactan

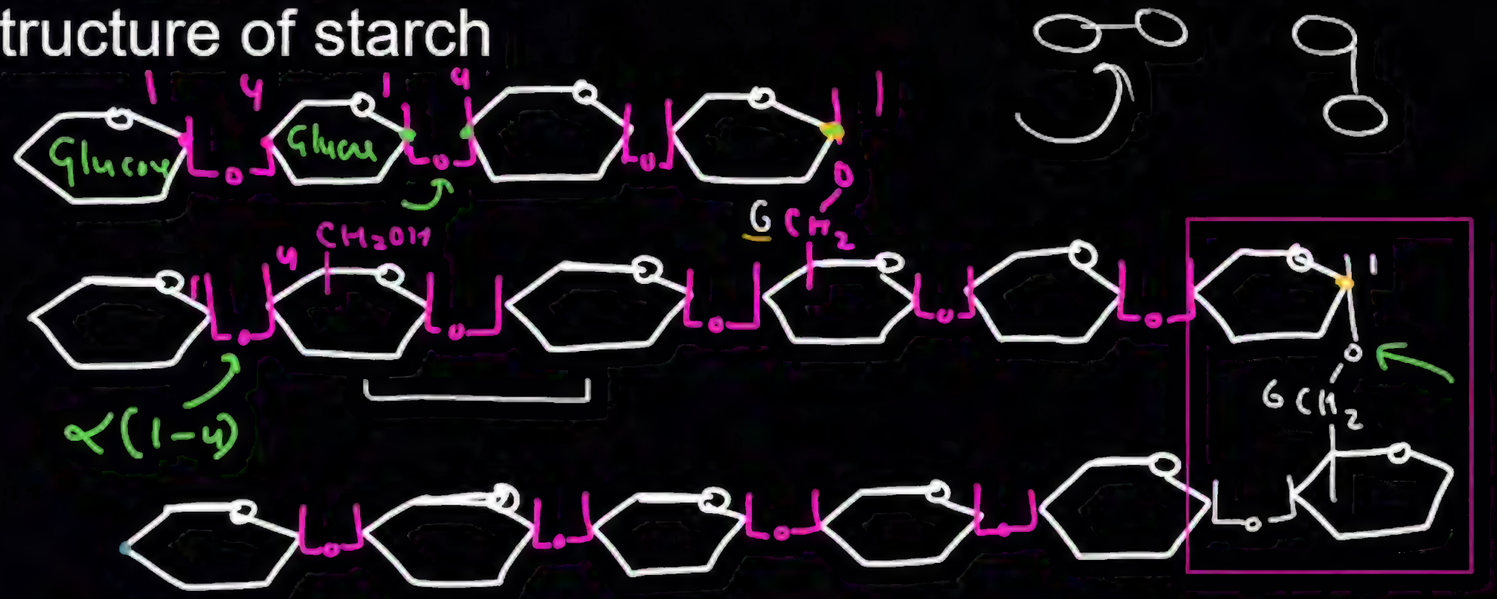
Storage

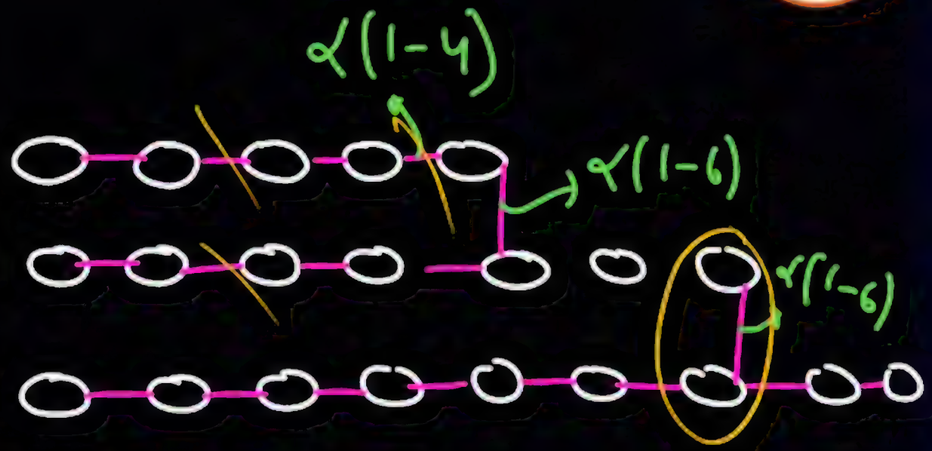
Ex- Starch – Polymer of α-D Glucose
- Glycogen – Polymer of α-D Glucose
- Inulin (Polymer of Fructose) → Homopolymer

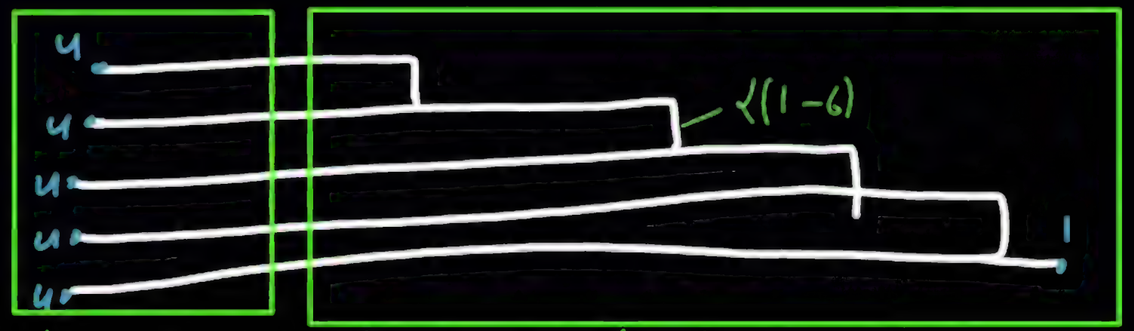
Structural – Part of cell wall
– Cellulose
– Chitin (Fungi cell wall, Arthropod Exoskeleton get hard with $CaCO_3$
– Peptidoglycan

note- Insulin – Protein [Hormone, Heteropolymer]

Structure of starch



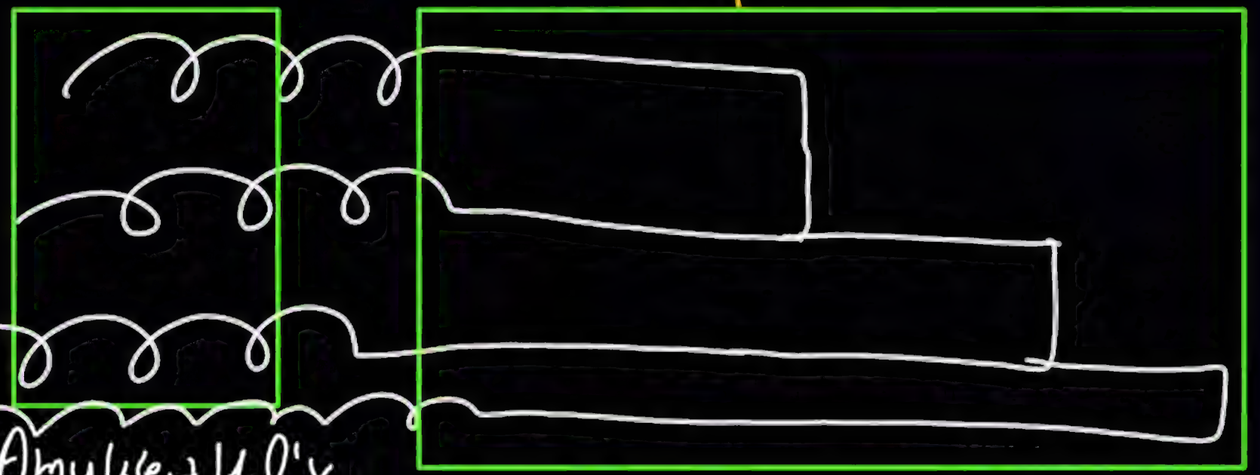




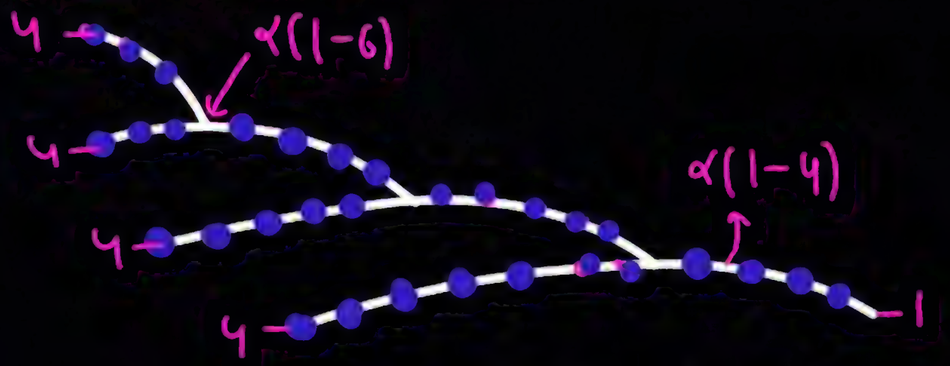
- $\alpha(1-4)$ Amylose
- 20%
- Water soluble

$\alpha(1-4)$ $\alpha(1-6)$ Amylopectin
80%
- Water insoluble

Amylopectin



Amylose → Helix
I_2 trap - Blue Black Colour



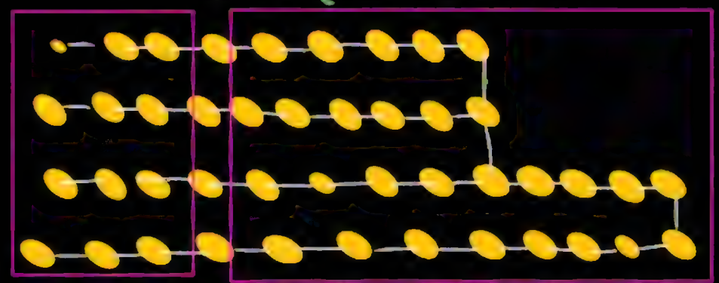
Starch is Homopolymer of α-D Glucose

→ Two type of Bond → α(1-4)
α(1-6) - Branch

→ Starch → Two component → (a) Amylose (water soluble, 20% starch, Form helix) α(1-4)

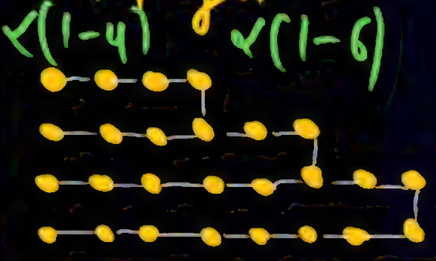
(b) Amylopectin → 80% Starch (α(1-4) 80% part, α(1-6) water insoluble)

α(1-4) α(1-6) Starch



= Amylose + Amylopectin
- Soluble than Glycogen
- Storage in Plant

Glycogen

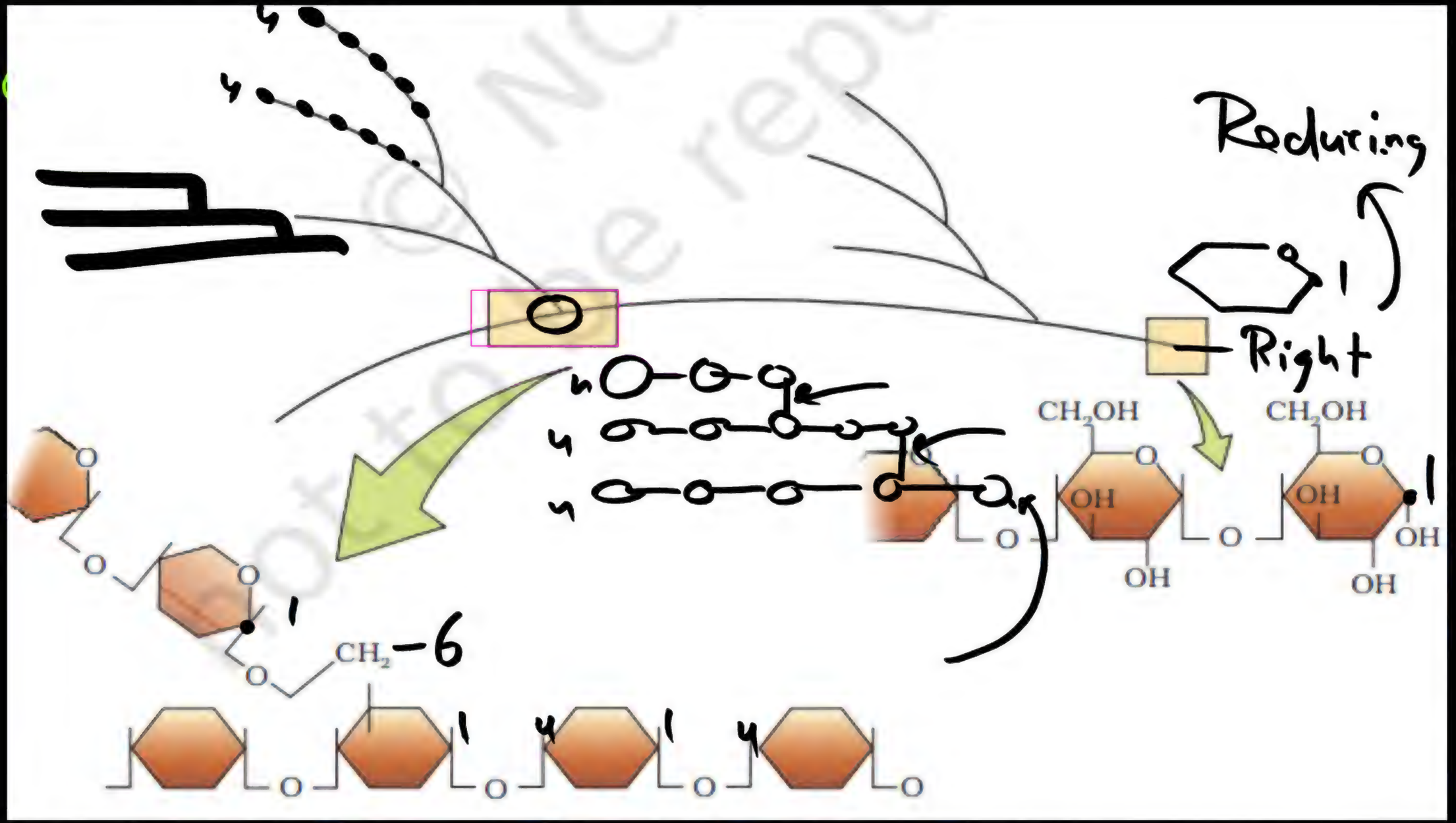


Similar to Amylopectin
(More Branch)
(More insoluble)
Storage in Animal

Q Which is most soluble

(a) Amylose
(b) Starch
(c) Glycogen
(d) Amylopectin

a > b > c = d


Reducing
Right
CH2OH
CH2OH
OH
OH
OH
OH
CH2
6
1
4

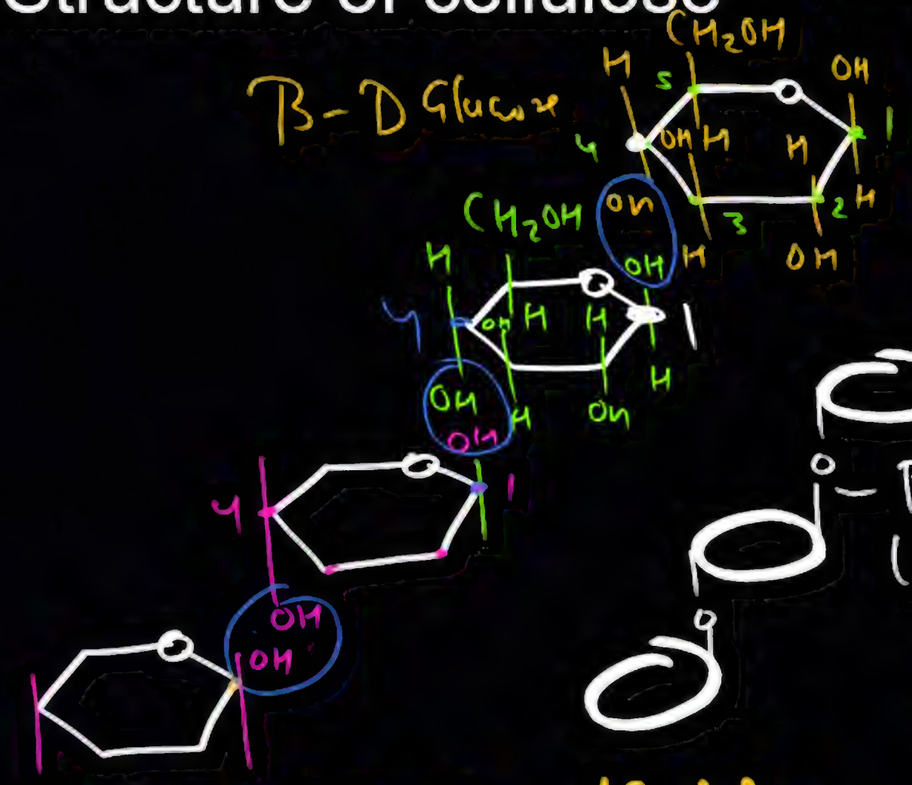
9.5 Polysaccharides

The acid insoluble pellet also has polysaccharides (carbohydrates) as another class of macromolecules. Polysaccharides are long chains of sugars. They are threads (literally a cotton thread) containing different monosaccharides as building blocks. For example, cellulose is a polymeric polysaccharide consisting of only one type of monosaccharide i.e., glucose. Cellulose is a homopolymer. Starch is a variant of this but present as a store house of energy in plant tissues. Animals have another variant called glycogen. Inulin is a polymer of fructose. In a polysaccharide chain (say glycogen), the right end is called the reducing end and the left end is called the non-reducing end. It has branches as shown in the form of a cartoon (Figure 9.2). Starch forms helical secondary structures. In fact, starch can hold I_2 molecules in the helical portion. The starch-I_2 is blue in colour. Cellulose does not contain complex helices and hence cannot hold I_2.

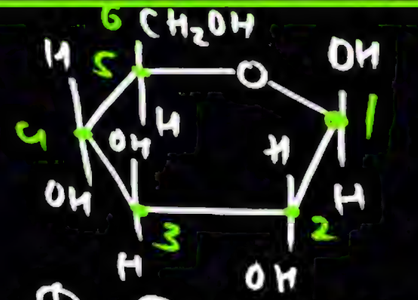
Plant cell walls are made of cellulose. Paper made from plant pulp and cotton fibre is cellulosic. There are more complex polysaccharides in nature. They have as building blocks, amino-sugars and chemically modified sugars (e.g., glucosamine, N-acetyl-galactosamine, etc.). Exoskeletons of arthropods, for example, have a complex polysaccharide called chitin. These complex polysaccharides are mostly homopolymers.

Cellulose & Hemicellulose

Structure of cellulose — Polymer of β-D Glucose


β-D Glucose
CH_2OH
OH
H
O
1
2
3
4
5
6
OH
OH
OH

structure of Chitin



B-D Glucose

At C-2 NH_2 Add

R-D Glucose

Acetylation

CH_3COOH

NH_2

(Amino Sugar)

N-Acetyl Glucose Amine

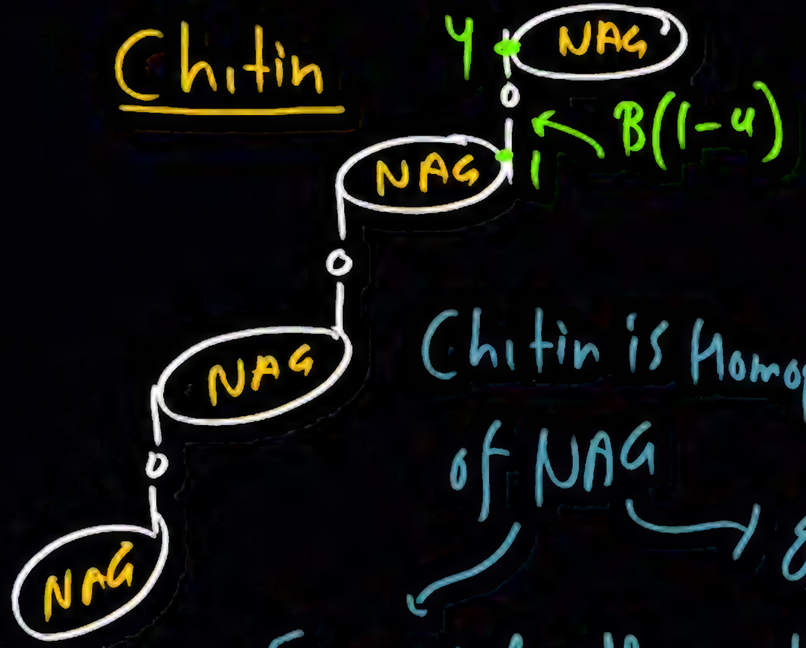
NAG

$NHCOCH_3$

NAM

Muraminic Acid $NHCOCH_3$

Chitin

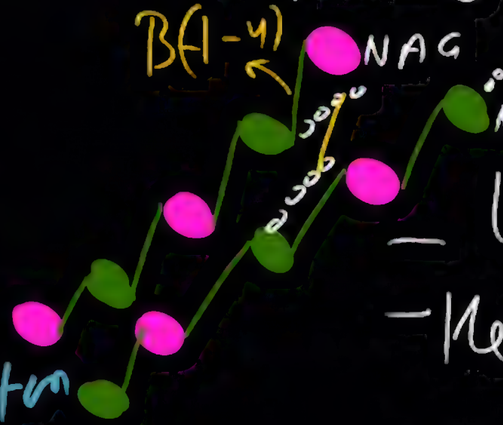


Chitin is Homopolymer of NAG

→ Exoskeleton of Arthopod

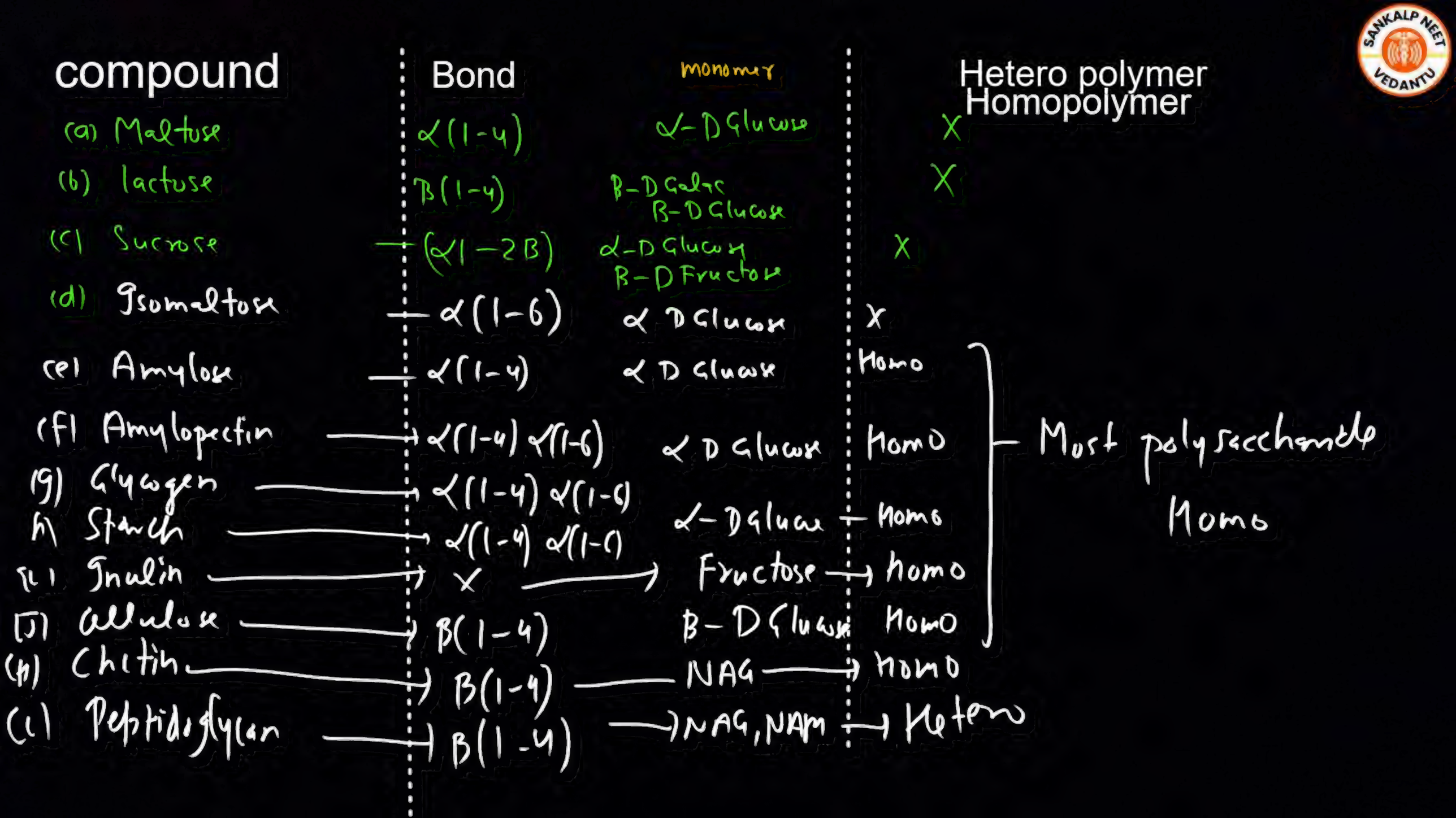
Fungi cell wall

Peptidoglycan (Bacterial cell wall)



– linkage B(1-4)

– Heteropolymer


compound
Bond
monomer
Hetero polymer
Homopolymer
(a) Maltose
α(1-4)
α-D Glucose
X
(b) lactose
β(1-4)
β-D Galac
β-D Glucose
X
(c) Sucrose
(α1-2β)
α-D Glucose
β-D Fructose
X
(d) Isomaltose
α(1-6)
α D Glucose
X
(e) Amylose
α(1-4)
α D Glucose
Homo
(f) Amylopectin
α(1-4) α(1-6)
α D Glucose
Homo
(g) Glycogen
α(1-4) α(1-6)
(h) Starch
α(1-4) α(1-6)
α-D Glucose
Homo
(i) Inulin
X
Fructose
Homo
(j) Cellulose
β(1-4)
β-D Glucose
Homo
(k) Chitin
β(1-4)
NAG
Homo
(l) Peptidoglycan
β(1-4)
NAG, NAM
Hetero
Most polysaccharide
Homo

Q

Q

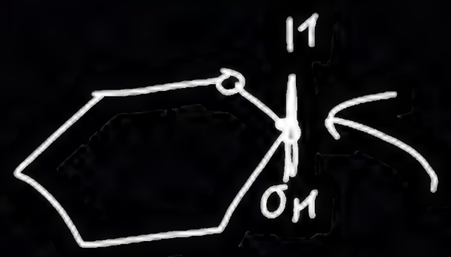
some part of Biomolecule

old def, new def

– Carbohydrate – Revise → 3-C → 7C

DiHA, Glyceraldehy

Ribose, Deoxyribose Ribulose (5C, Ketose)



β-D Glucose

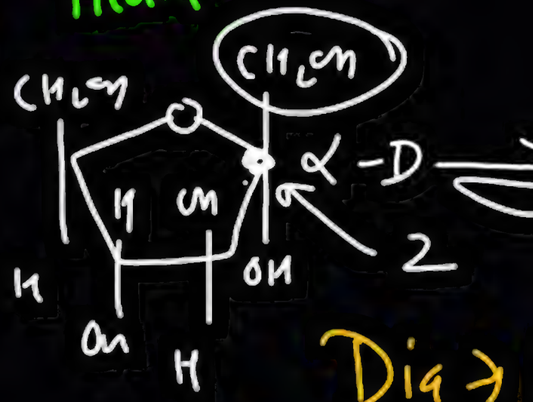
α-D Glucose

β-D Galactose

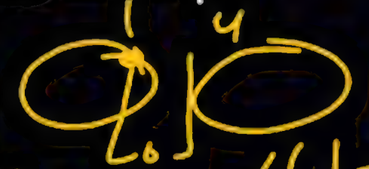
Glu, Gala, Fru

Aldose

Anomeric Carbon
Glu, Gala



α-D ⇌ β-D Fructy



α(1-4)

Dia → Malto

Lactose → Gala — Glu β(1-4)

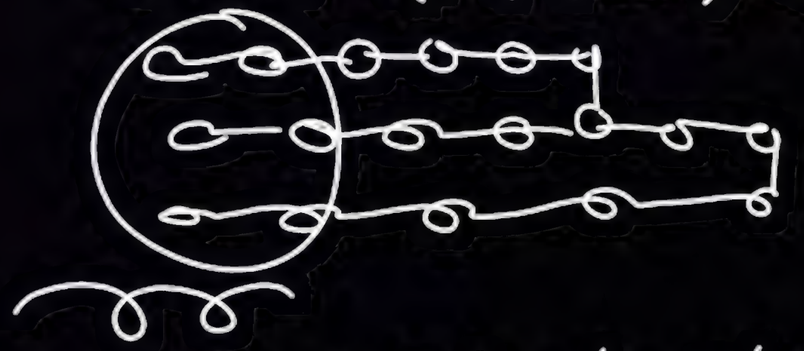
β β

Sucrose → α-D Glucose

β-D Fru

Starch → α(1-4) (α 1-6) → Amylose α(1-4)
Amylopectin α(1-4) α(1-6)

Glycogen α(1-4)
α(1-6)

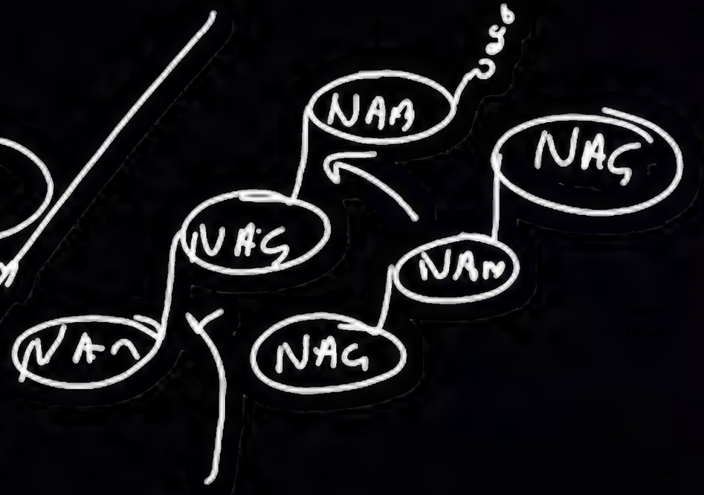


→ Cellulose (→ β(1-4)

Chitin

Glu → NAG → NAM

NAG
NAG
Chitin → Fungi
→ Arthropoda



About carbohydrate

① optically inactive Sugar → Dihydroxyacetone

② Non-Reducing Sugar ⟶ Sucrose, Raffinose (trisaccharide)

③ Invert Sugar ⟶ Sucrose ($C_{12}H_{22}O_{11}$) + H_2O ⟶ (Hydrolysis) Glucose + Fructose
is Sucrose (Dextro rotatory) — combine solution — laevorotatory

④ Glucose → Blood sugar, Grapes Sugar ✓
Fructose → Fruit sugar (sweetest)

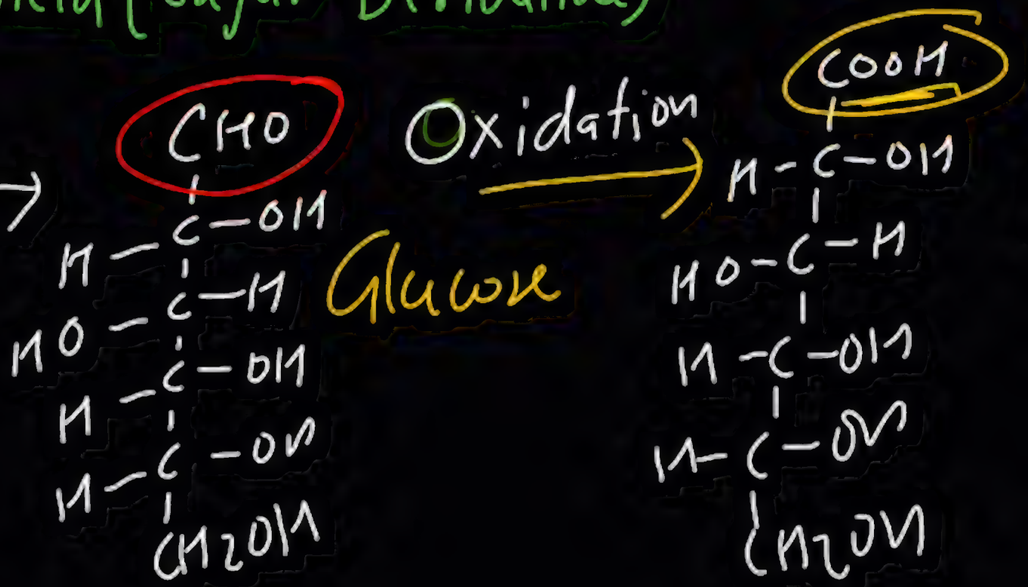
⑤ Disaccharide → Sucrose → Cane Sugar, table Sugar, Invert Sugar, non-reducing
Lactose → Milk Sugar
Maltose → Malt sugar (Starch hydrolysis give this)

(6) Agar is Polymer of — Galactose

(7) Starch → α(1-4) α(1-6) linkage, Amylose (α(1-4)), Amylopectin (α(1-4) α(1-6)) → helix Form → I_2 trap

(8) Cellulose → β(1-4), Pulp of paper, wood, Cotton fibre
Cell wall of plants

(9) Vit-C → Ascorbic Acid (Sugar Derivative)

(10) Gluconic Acid → 

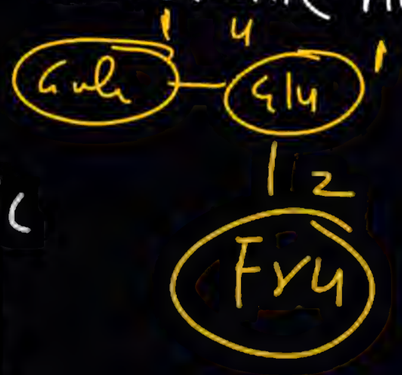
Q Which is Reducing

(a) Raffinose X

(b) Sucrose X

(c) Maltose

(d) Gluconic Acid X



Analysis of Biomolecule

→ All Living tissue (Plants, Animals) ⟶ Elemental Analysis ⟶ C, H, O, N & other Elements

Similar Analysis of Earth crust (Part) ⟶ Same Element (But few Extra)

S-I Few Elements Found in tissue not in Earth ✗

S-II Few Elements Found in Earth not in tissue ✓

TABLE 9.1 A Comparison of Elements Present in Non-living and Living Matter*

Element	% Weight of Earth's crust	% Weight of Human body
Hydrogen (H)	0.14	0.5
Carbon (C)	0.03	18.5
Oxygen (O)	46.6	65.0
Nitrogen (N)	very little	3.3
Sulphur (S)	0.03	0.3
Sodium (Na)	2.8	0.2
Calcium (Ca)	3.6	1.5
Magnesium (Mg)	2.1	0.1
Silicon (Si)	27.7	negligible

* Adapted from CNR Rao, *Understanding Chemistry*, Universities Press, Hyderabad.

H_2O

Human Body

O > C > N > Ca > H

a Most Abundant Element in Human Body

Ca N ~~Si~~ O Ca C ~~Si~~ H

H_2O + Carbon

How to Analyse organic compound in living tissue

Living → (a) Elemental Analysis
(b) which type organic compound → M.W & Function Based ✓
→ Functional Group ✓

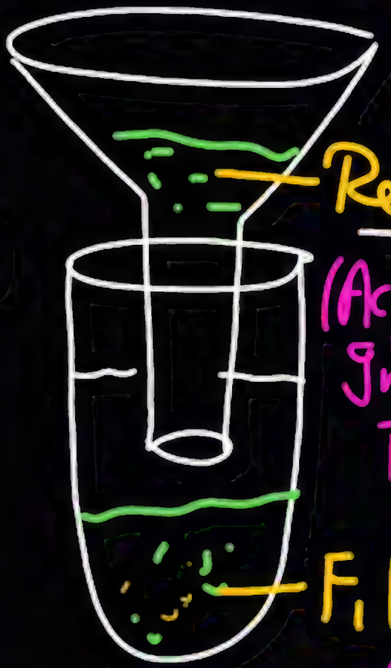
Leaf (Plant tissue)

Liver tissue (Animal tissue)

→ Mortar & pestle

trichloro acetic Acid CCl_3COOH →

thick Slurry →



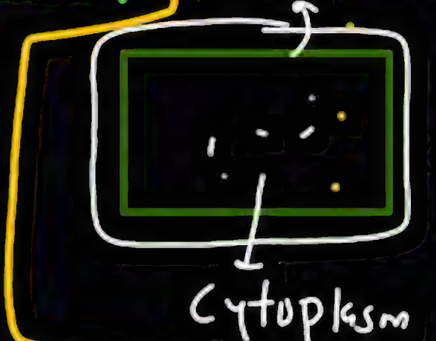
(trichloro Acetic Acid)

Acid soluble pool | Filterate

→ low M.W (18 dalton – 800 dalton)

→ ions (Na^+, k^+, Cl^-, Mg^{+2})
→ Amino Acid
→ Nitrogenous Base, Nucleotide
→ Sugars (Mono & Disaccharide) ✓

normally – Biomicromolecule
– Mainly – Cytoplasmic Component



Acid insoluble
(Retentate)

– M.W → high (More than 800 dalton)

– Proteins
– Nucleic Acid
– Polysaccharides
] Polymer

– Lipid (M.W low But it come in AIP)
(not polymers)
(It Form Aggregation

– normally → Biomacromolecule
→ Cytoplasmic + wall component

Q1 Palmitic Acid (Fatty acid)

(a) AIP (b) Form Aggregation (c) Biomicromolecule (d) all (Low M.W)

Q2 Fructose, Na^+, Glucagon, t-RNA, Arachidonic Acid, thymine, Sucrose

ASP ASP AIP AIP AIP ASP ASP

How many are in ASP →

(a) two (b) three (c) Four

(d) Five

Q How many are polymeric → two (Arachidonic is in AIP But not Polymeric)

Q3 → Starch, Glycogen, inulin, Ribosome, K^+, Fructose, ATP, Phospholipid

AIP AIP AIP AIP AIP ↗ ↗ AIP

Metabolite – Inside cell Biomolecules → constantly convert one Compound to other → known as **Metabolite**

Primary metabolite

- Starch, Glucose, Nucleotide DNA → Role identifiable
- Present in all type of cells

Secondary metabolite

Plant cells, Fungi & Bacteria → Form Some Chemicals → Role non-identifiable But For human some important

Ex – Nicotine
→ Anthocyanin

TABLE 9.3 Some Secondary Metabolites

Category	Example
Pigments	Carotenoids, Anthocyanins, etc.
Alkaloids	Morphine, Codeine, etc.
Terpenoides	Monoterpenes, Diterpenes etc.
Essential oils	Lemon grass oil, etc.
Toxins	Abrin, Ricin (Castor)
Lectins	Concanavalin A
Drugs	Vinblastin, curcumin, etc.
Polymeric substances	Rubber, gums, cellulose

Secondary Metabolite
↓
non-identifiable
↓
Human some importance

Q Which is not Secondary metabolite
(a) Abrin (b) Lemon grass oil
(c) Glycine (d) Morphine

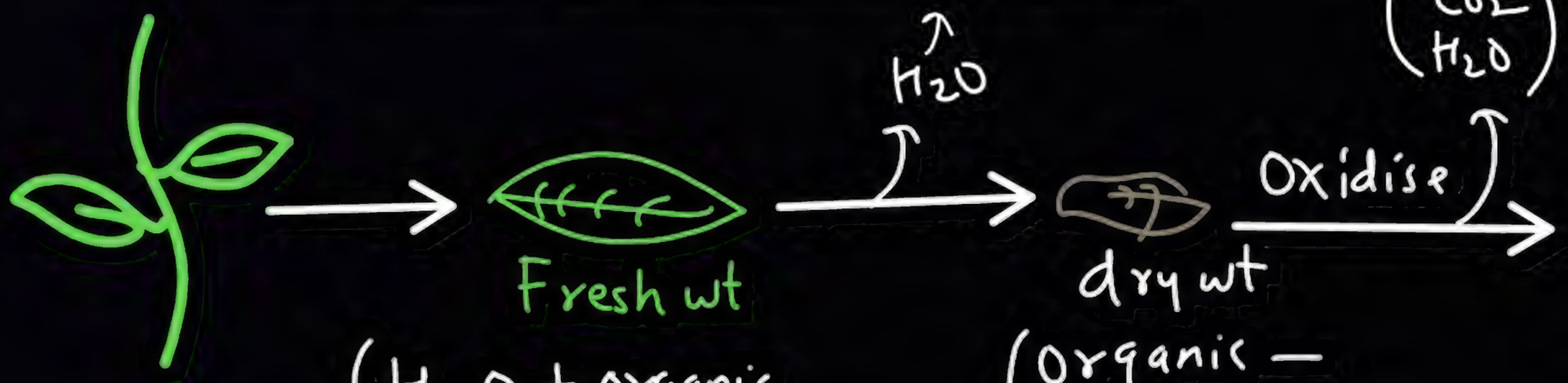
9.2 Primary and Secondary Metabolites

The most exciting aspect of chemistry deals with isolating thousands of compounds, small and big, from living organisms, determining their structure and if possible synthesising them.

If one were to make a list of biomolecules, such a list would have thousands of organic compounds including amino acids, sugars, etc. For reasons that are given in section 9.10 we can call these biomolecules as 'metabolites'. In animal tissues, one notices the presence of all such categories of compounds shown in Figure 9.1. These are called primary metabolites. However, when one analyses plant, fungal and microbial cells, one would see thousands of compounds other than these called primary metabolites, e.g. alkaloids, flavonoids, rubber, essential oils, antibiotics,

coloured pigments, scents, gums, spices. These are called **secondary metabolites** (Table 9.3). While primary metabolites have identifiable functions and play known roles in normal physiologial processes, we do not at the moment, understand the role or functions of all the 'secondary metabolites' in host organisms. However, many of them are useful to 'human welfare' (e.g., rubber, drugs, spices, scents and pigments). Some secondary metabolites have ecological importance. In the later chapters and years you will learn more about this.

Elemental Alalysis



Q Ash wt inulw
(a) organic (c) water
(b) inorganic
(d) organic + inorganic

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SANKALP NEET VEDANTU

sexual Reproduction in Flowering plants

Botany

TARUN SIR

Class 12th

- SRFP → 3-4Q → Pure NCERT → Link to plant kingdom

- **Principles of inheritance** → 5-6 → 9
- **Molecular Basis of inheritance** → 6-7Q → 10
- Microbes → 1Q-2Q — 1 Lecture (Recorded)

Ecology → Organism & Population → 4
Ecosystem → 3
Biodiversity → 2

(7-8Q)
8-9 lecture

Topics

1. Structure of Anther & Gametogenesis
2. Structure of pistil & Gametogenesis
3. Pollination, Outbreeding devices
4. Pollen pistil interaction
5. Double Fertilization
6. Embryo development
7. Seed development
8. Fruit development
9. Apomixis & Polyembryony

SANKALP NEET VEDANTU

Today's Goal

→ Structure of stamen, Gametogenesis

Basic introduction

→ Angiosperm → main plant Body (Sporophyte = 2n)
Root, Stem, Leaf, Flower → 2n – Sporophytic Generation

Seed → germinate → Plant → Growth → Floral Bud → Flower → Seed → Fruit

(Vegetative phase) (Reproductive phase)

Reproductive phase → Hormonal Change → Floral Bud → Flower Form
Structural Change

→ Three part Divide –

→ Pre Fertilization changes – Stamen & Pistil develop
Gametes Form
Pollination

→ Fertilization – Syngamy, triple Fusion

→ Post Fertilization changes → seed & Fruit development
Embryo development

Q Which is not part of Reproductive phase

(a) Seed development (b) Pollination (c) Seed germination (d) Fruit development

2.1 Flower – A Fascinating Organ of Angiosperms

Human beings have had an intimate relationship with flowers since time immemorial. Flowers are objects of aesthetic, ornamental, social, religious and cultural value – they have always been used as symbols for conveying important human feelings such as love, affection, happiness, grief, mourning, etc. *List at least five flowers of ornamental value that are commonly cultivated at*

homes and in gardens. Find out the names of five more flowers that are used in social and cultural celebrations in your family. Have you heard of floriculture – what does it refer to?

To a biologist, flowers are morphological and embryological marvels and the sites of sexual reproduction. In class XI, you have read the various parts of a flower. Figure 2.1 will help you recall the parts of a typical flower. Can you name the two parts in a flower in which the two most important units of sexual reproduction develop?

2.2 Pre-fertilisation: Structures and Events

Much before the actual flower is seen on a plant, the decision that the plant is going to flower has taken place. Several hormonal and structural changes are initiated which lead to the differentiation and further development of the floral primordium. Inflorescences are formed which bear the floral buds and then the flowers. In the flower the male and female reproductive structures, the androecium and the gynoecium differentiate and develop. You would recollect that the androecium consists of a whorl of stamens representing the male reproductive organ and the gynoecium represents the female reproductive organ.

PRE Fertilization Changes → Structure of stamen

- Stamen is male Reproductive organ in Flower (Whorl of stamen - Androecium)

Stamen → Two part
(a) Anther
(b) Filament

- Filament – Long, slender Stalk
- Proximal end Attach on thalamus or petal (Epipetalous Solanaceae)
- Length of Filament - variable (Stamens length can be unequal)

Q Fertile tissue in Stamen located in
(a) Anther
(b) Filament
(c) Both
(d) none

(NEET-2017)

Can give Gamete

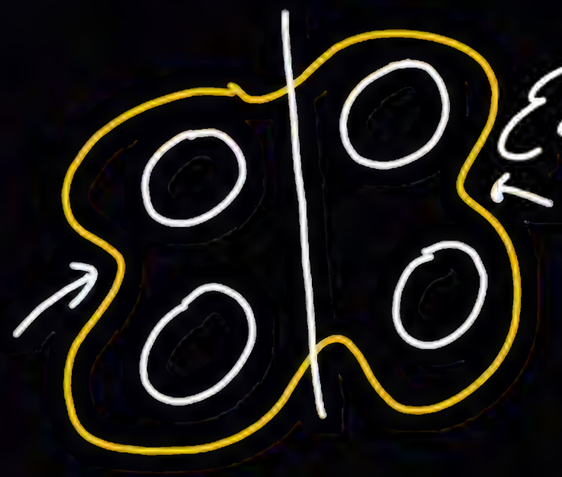
Detail of Anther

→ typical Angiosperm Anther → two lobe – Bilobe Anther

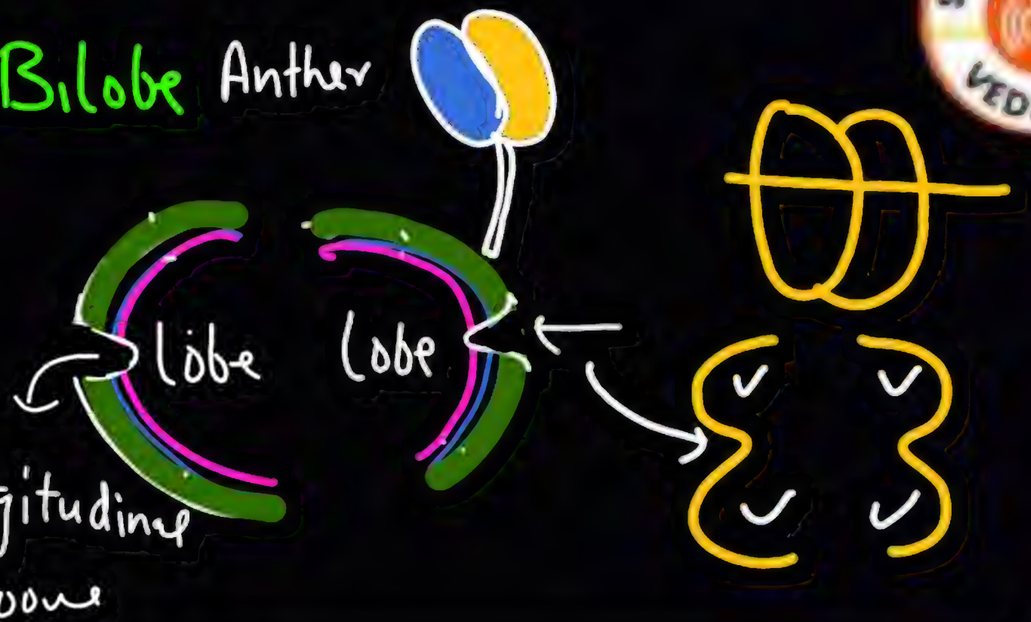
→ Each Lobe have → Two theca (layer)

→ longitudinal Groove seperate two theca

⇒ Inside Anther → 4 corners Form (tetragonal)



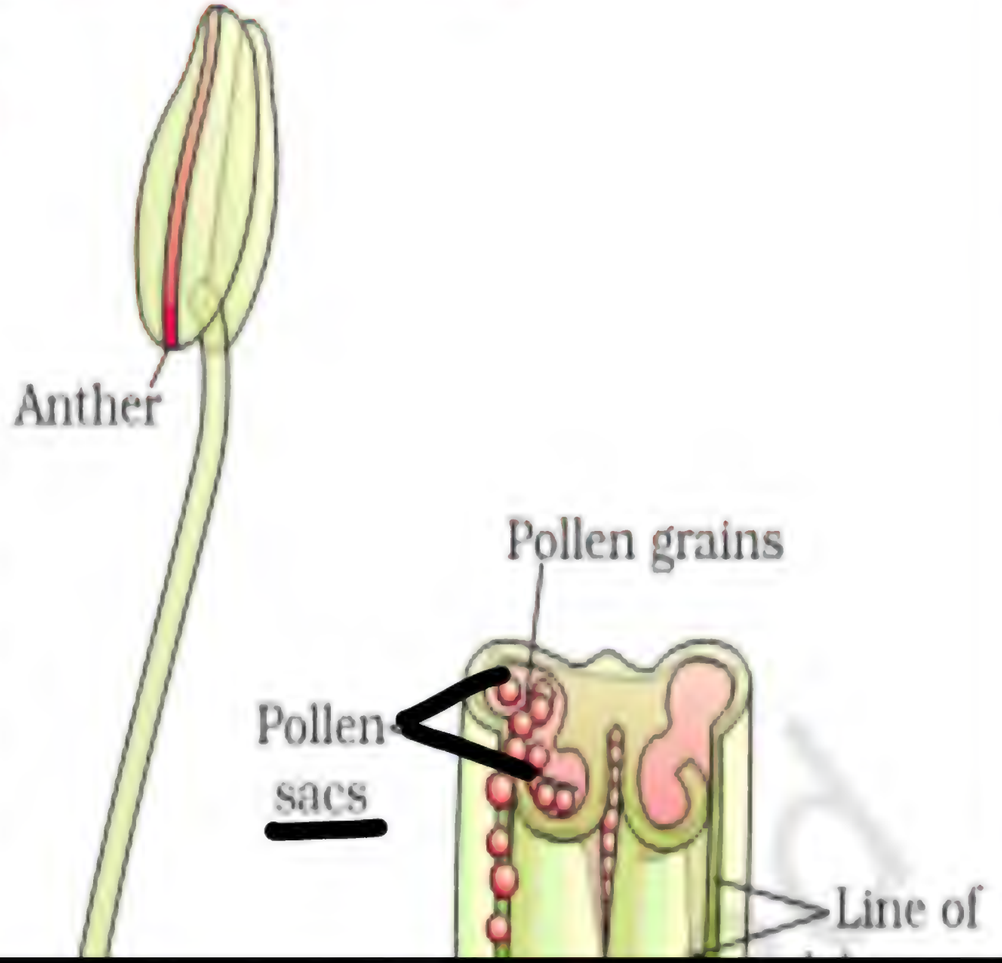
Each corners have Microsporangium (Circular outline)



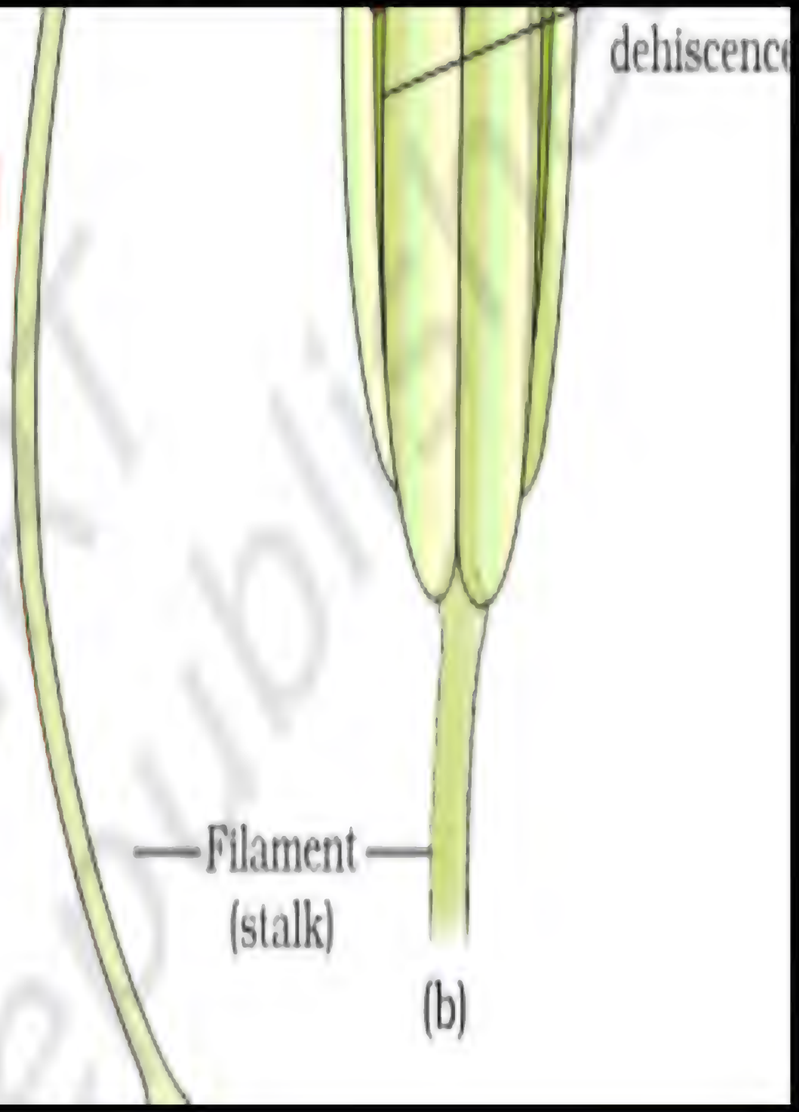
Microsporangium =	Single
Microsporangia	Many

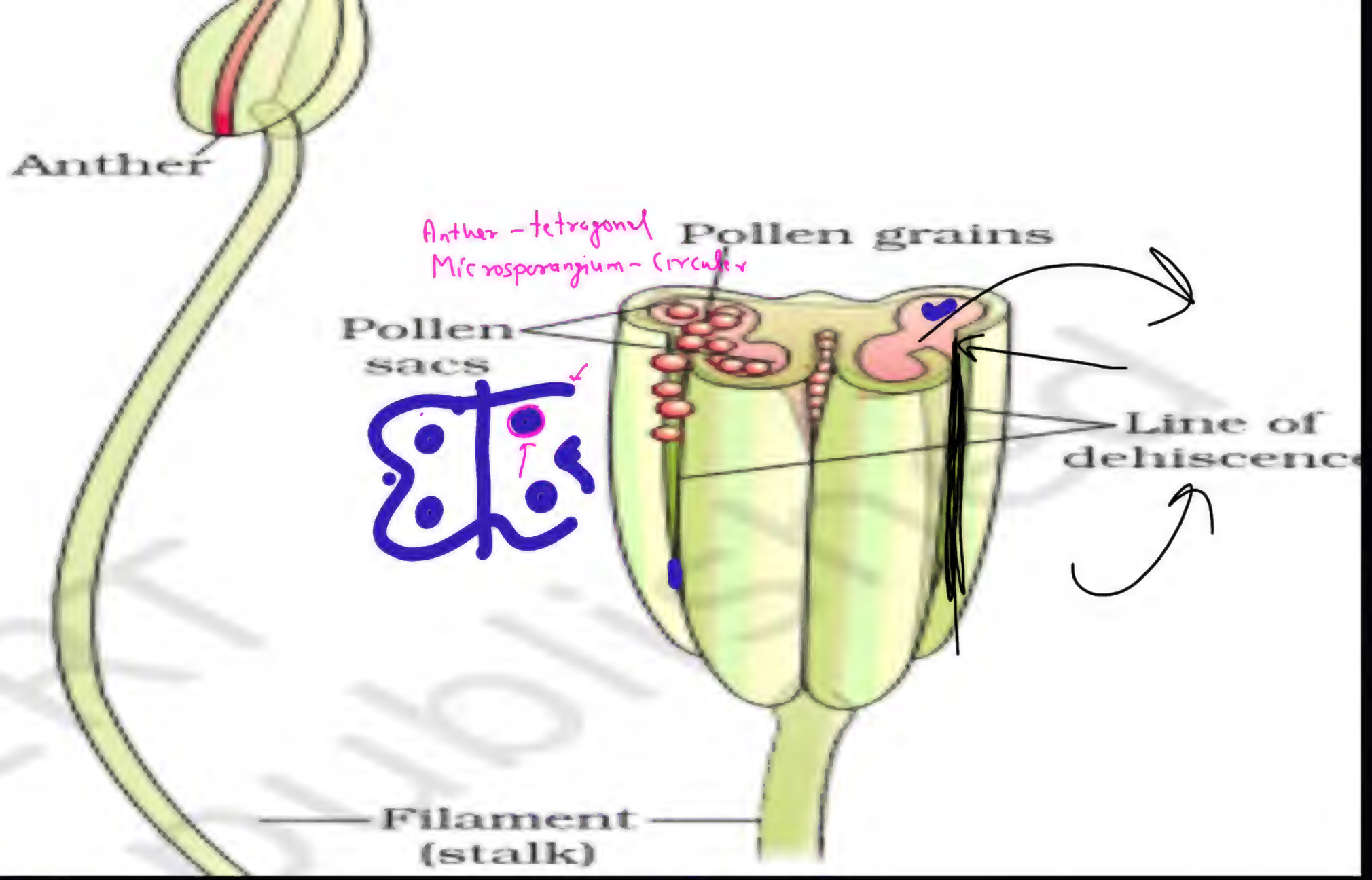
2.2.1 Stamen, Microsporangium and Pollen Grain

Figure 2.2a shows the two parts of a typical **stamen** – the long and slender stalk called the **filament**, and the terminal generally bilobed structure called the **anther**. The proximal end of the filament is attached to the thalamus or the petal of the flower. The number and length of stamens are variable in flowers of different species. If you were to collect a stamen each from ten flowers (each from different species) and arrange them on a slide, you would be able to appreciate the large variation in size seen in nature. Careful observation of each stamen under a dissecting microscope and making neat diagrams would elucidate the range in shape and attachment of anthers in different flowers.

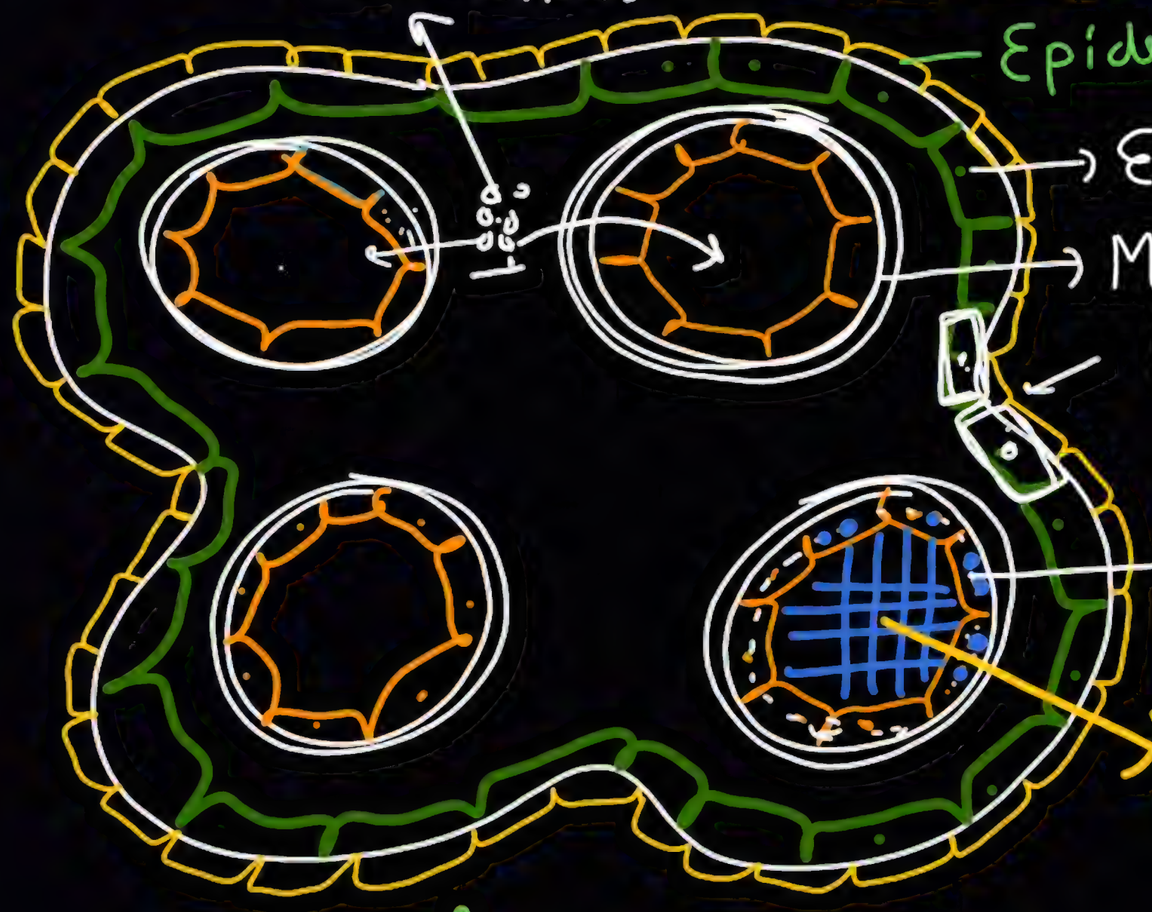


A typical angiosperm anther is **bilobed** with each lobe having two theca, i.e., they are **dithecous** (Figure 2.2 b). Often a longitudinal groove runs lengthwise separating the theca. Let us understand the various types of tissues and their organisation in the transverse section of an anther (Figure 2.3 a). The bilobed nature of an anther is very distinct in the transverse section of the anther. The anther is a four-sided (tetragonal) structure consisting of four **microsporangia** located at the corners, two in each lobe.




Anther
Anther - tetragonal
Microsporangium - Circular
Pollen grains
Pollen sacs
Line of dehiscence
Filament (stalk)

structure of young Anther → Bilobe, tetragonal and have Four Microsporangium



T.S of young Anther

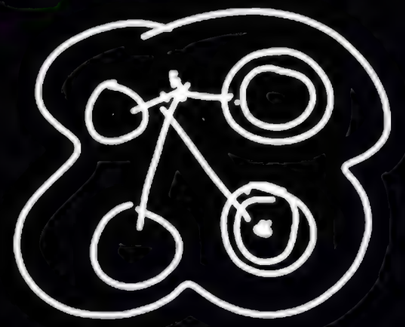
Undergo
Meiosis occur

layers in young Anther

(a) Epidermis – Outermost, Parenchyma cells
Role – protection

(b) Endothecium → large size cells, Cellulose thickening at Radial & tangential wall

When Anther dry → Absorb water ← Gap create B/w Endothecium cells



(c) Middle layer – Few layer thick
Pass nutrition From Connectives to inside

<u>note</u> → Outermost three layer – Epidermis, Endothecium & middle layer help in protection and dehiscence (Anther opening to Release pollen)

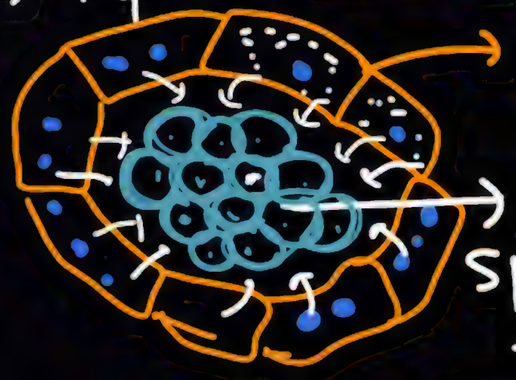
(4) Tapetum — Bi or Multinucleated, dense cytoplasm [Metabolically Active] ✓

Role of tapetum → (a) Provide nutrition to developing pollen ✓

(b) It Release Callase Enzyme ✓

(c) Exine → produce By tapetum (in Form Ubisch granule)

(d) Pollen kit (sticky) → produce By tapetum (Insect pollination)



Sporogenous tissue (2n)

Connection present

↓

Callose ✓

Connection Break

PMC

Each cell is now Pollen mother cell (Meiosis occur)

n (Microspore)

Tapetum Release Callase Enzyme

Spore tetrad

Microspore Seperate

↓

Can develop into pollen

Young Anther

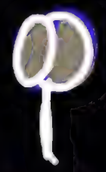
Microsporangium

Sporogenous tissue

→ All Four layers present (Epidermis, Endothecium, Middle layer, tapetum)

→ At Four corner - Microsporangium present

→ Sporogenous tissue (2n)

Dry & Dehydrate

Mature Anther

Pollen sac

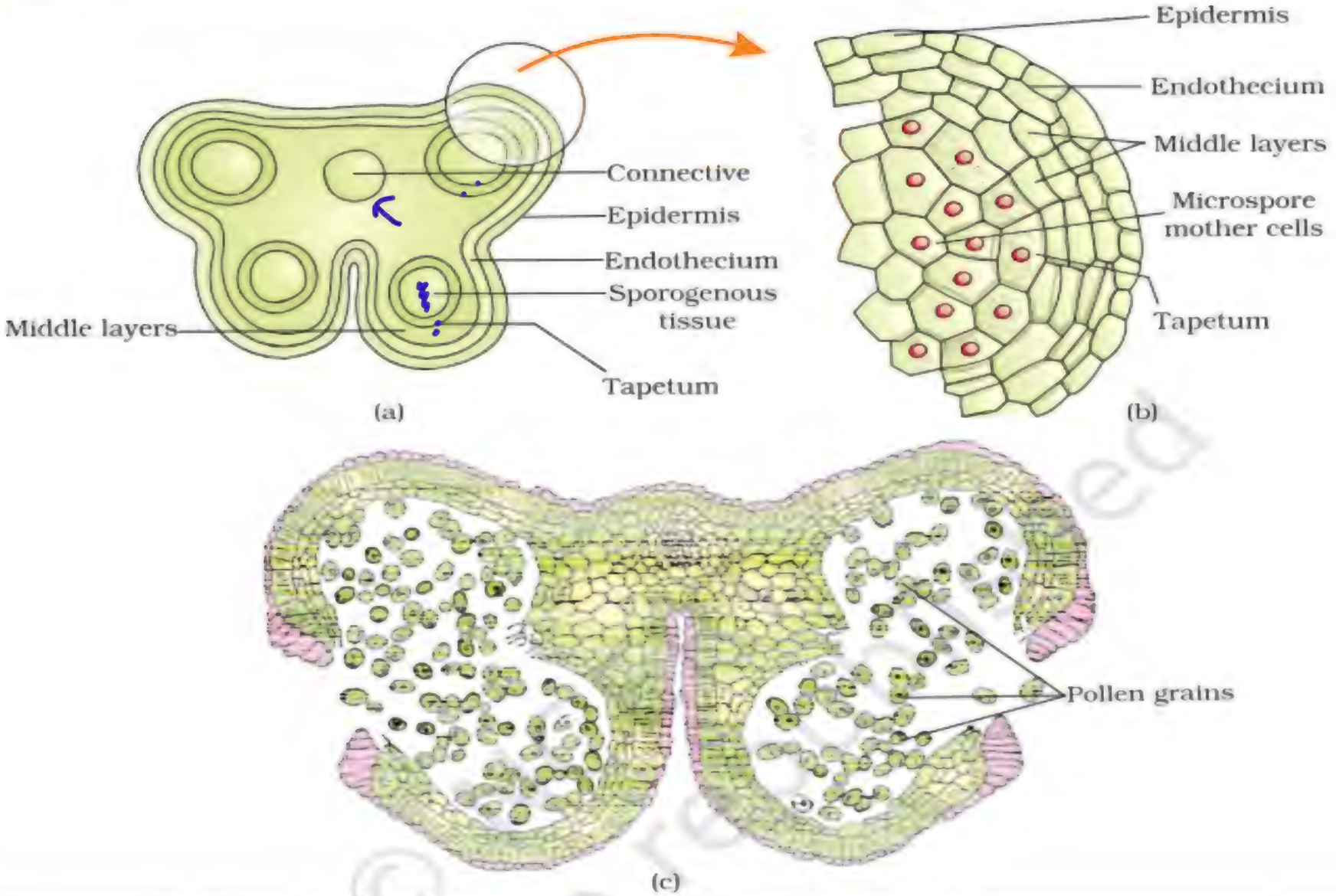
Pollen grain

Line of dehiscence — Pollen Release

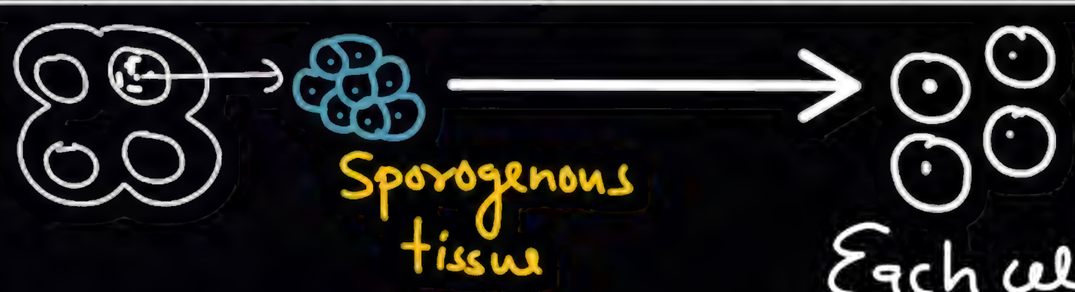
→ Two layers intact - Epidermis, Endothecium

→ Pollen sac present (4 pollen sac)

→ Pollen grain present (n)


Connective
Epidermis
Endothecium
Sporogenous tissue
Middle layers
Tapetum
(a)
Epidermis
Endothecium
Middle layers
Microspore mother cells
Tapetum
(b)
Pollen grains
(c)

How sporogenous tissue Give pollen grain



PMC (Pollen mother cell) or MMC (Microspore mother cell)

Each cell of Sporogenous tissue can undergo meiosis

Two step

(I) PMC (2n) —meiosis→ 4 haplod Spore / Microspore tetrad } Microsporogenesis (meiosis in PMC Result in 4 haploid cell)

(II) Each Microspore Give pollen grain

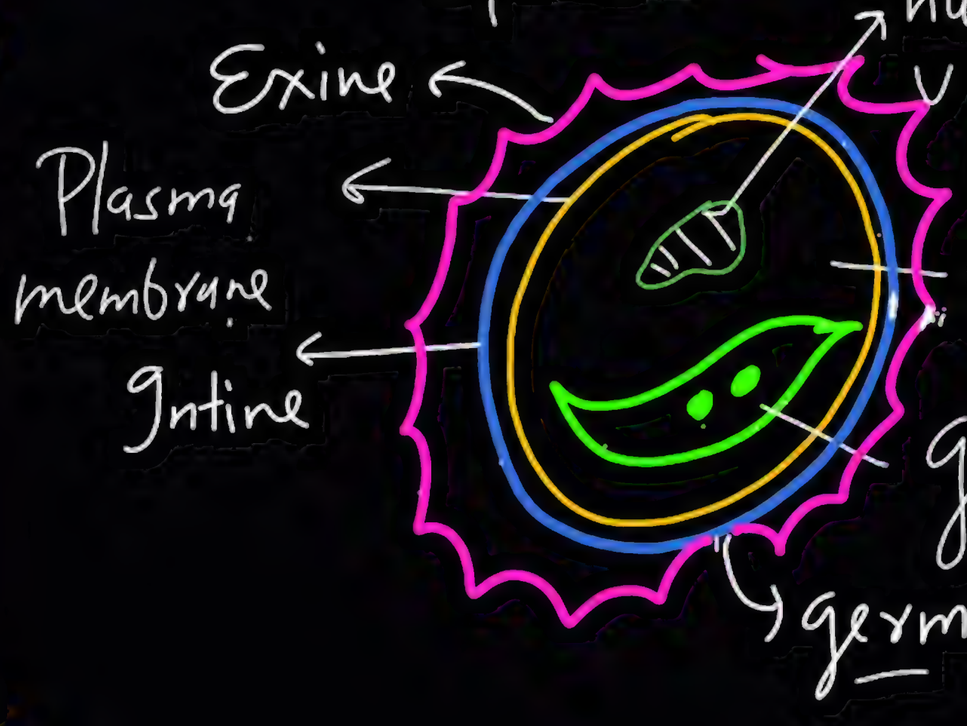
(Note - Spore Undergo mitosis to Give Gametophyte)

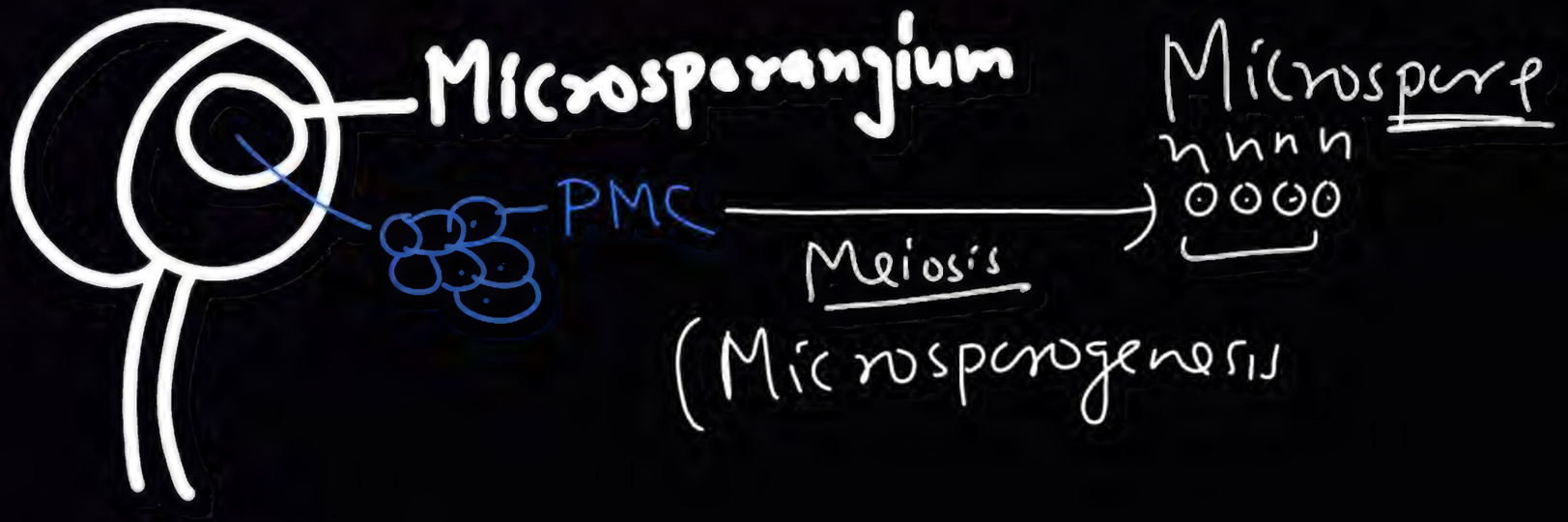
II Microspore to pollen grain

PMC (2n) → Meiosis (Microsporogenesis) → Spore tetrad (n) | 4 Microspore

Microspore (n) → Vacuole, nucleus → Mitosis, Asymmetric Spindle ✓ → Unequal size cell: Vegetative (n) cell, generative cell (n)

Pollen grain (Male gametophyte)




Microsporangium
PMC
Meiosis
Microspore
n n n n
0 0 0 0
(Microsporogenesis

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SANKALP NEET VEDANTU

sexual Reproduction in Flowering plants

lecture- 02

Botany

TARUN SIR

Today's Goal

Structure of Stamen and Microspongenesis

(2n) Microsporangium → PMC (2n) —Microsporogenesis (Meiosis)→ Microspore (n) → (n) (Microspore)

Stamen

1 Mitosis

Pollen grain (n)

(Male gametophyte)

Haploid & Diploid

Vegetative cell — n

Generative cell — n

] — Gametophytic generation

Anther — 2n

Stamen — 2n

tapetum, Epidermis — 2n

Endothelium — 2n

Middle layer — 2n

PMC — 2n

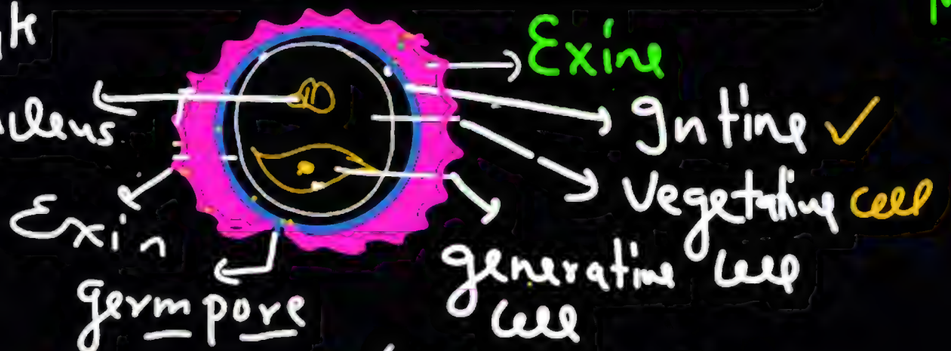
→ Sporophytic generation

structure of male gametophyte

(n) Microspore → Mitosis → (n) Gametophyte

Male gametophyte = pollen grain

Pollen grain = Male gametophyte
(20–50 µm)
Small, Round



(note – germ pore
Sporopollenin Absent
– pollen tube come Out)

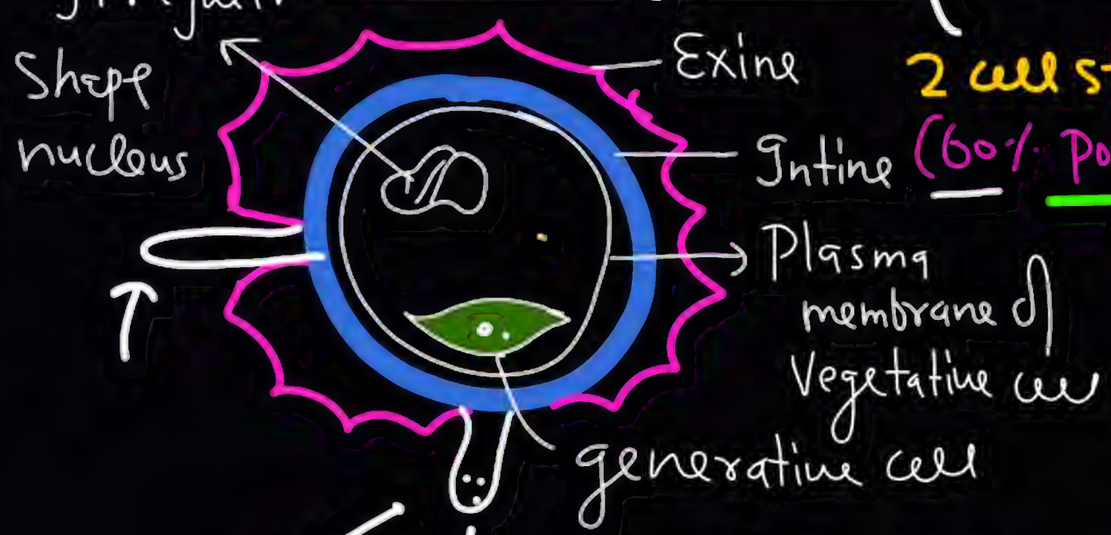
Intine

– Countinuous ✓
– made up of – pectin ✓ & Cellulose
– Role – It give Pollen tube ✓
(Intine made By – V.C (Gametophytic nature))

Exine (Protection)

– Discountinuous, Sculptured
– made up of – Sporopollenin (lipid) ✓
Sporopollenin – Resistant to Alkali, Acid, temp, Enzymes
(help pollen to preserve of Fossils)
Exine Release By → tapetum (Nature of Exine Sporophytic)

Mature pollen (2 cell stage or 3 cell stage)



2 cell stage
(60% Pollination - 2 cell stage)

nucleus of G.C Divide (Generative cell)

3 cell stage
(1 V.C + 2 male gamete)

2 male gamete

Vegetative cell

- Large size cell
- → Pollen tube Form
- → Food Reserve present
- → Nucleus - Irregular shape

Generative cell

- → Small size cell
- → Spindle shape - Float in cytoplasm of V.C
- → dense cytoplasm
- → It Divide to Form two male gamete

Extra topics

Pollen allergy

Some pollen grain ⟶ Can Cause Bronchial Affliction & Asthma
(Inhale with Air)

Ex- Parthenium (Weed) (Carrot Grass) — Come in India → with imported wheat (From USA)

- Spread Everywhere (Ubiquitous)
- Pollen → Cause Allergy

Pollen as Food supplements

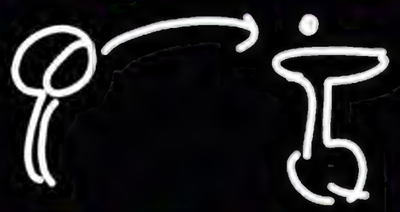
- Some Western countries → Pollen as a tablet & syrup available as Food Supplements

Source of nutrients → helpful Athletes & horses

Extra topics

viability of pollen → Pollen Release From Anther → on stigma Germinate (Pollentube)

↳ Maximum time upto which → pollen can germinate After pollination



- Wheat, paddy → viability - half an hour
- Solanaceae, leguminosaceae, Rosaceae (some members) → Viability For months)

IV **Pollen bank** - Pollen grain (haploid) - Store in liquid N_2 ($-196^{\circ}C$)

Use → (a) Storage of genome ✓ (haploid set of chromosome - Genome)

(b) Use in plant breeding Experiment ✓

note → It is Ex-situ conservation

Q In a Flower with 10 stamen (Each with Four microsporangium)
Each Microsporangium have 20 PMC
calculate total pollen and male gamete (6400)

1 Flower → 10 stamen ⟶ 10 × 4 = 40 microsporangium

40 × 20 ∋ 800 PMC ✓

↓ Meiosis

3200 Pollen grain

Female structure and Gametogenesis

Carpel or Pistil – Female Reproductive Structure [Whorl of Carpel – Gynoecium

Structure of Pistil

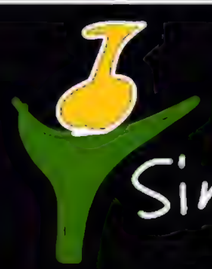
Stigma (2n) ⟶ landing platform Form pollen

Style (2n) → Below stigma, narrow, tube like, Hollow

(locule) Chamber ← Ovary (2n) → Ovary – Basal, Bulge part, inside ovary Chamber present (known as locule)

Inside locule (Placenta present – on which ovule attach

Number of carpel



Single carpel

Monocarpellary

Ex – Wheat, Mango

Fabaceae

Carpel Free

Bicarpellary (Apocarpus)

Bicarpellary (Syncarpus)

Multicarpellary ✓ Apocarpus → Ex Michelia

Multicarpellary Syncarpus → Ex – Papaver

(Class 12th NCERT

ovarian Cavity | locule

(Inside locule – placenta present)

Hilum – Point of Attachment of Funicle on ovule

Funicle – stalk attach ovule on placenta

number of ovule

(a) Inside ovary – Single ovule

(than single seed in Fruit

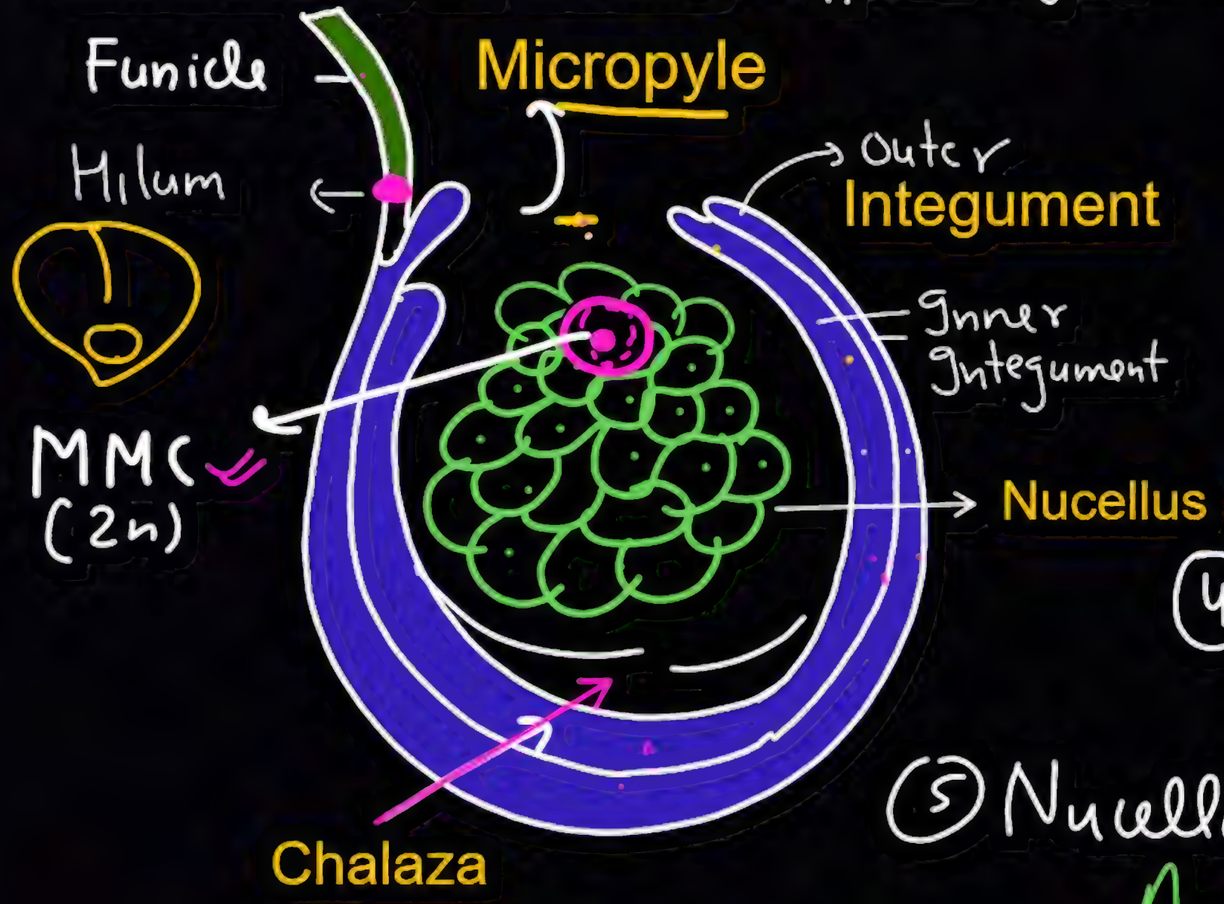
Ex – Wheat, paddy, Mango

(b) Many ovule inside ovary

(Inside Fruit many seed)

Ex – Watermelon
Papaya
Orchids

Structure of ovule - Typical Angiosperm



Ovule - Anatropous ←

Ovule = Megasporangium

① Funicle - stalk ② Hilum - Point of Attachment

③ Integument - Hard protective layers (Enclose Nucellus) at Micropyle - Integument Absent (Pollen tube Enter)

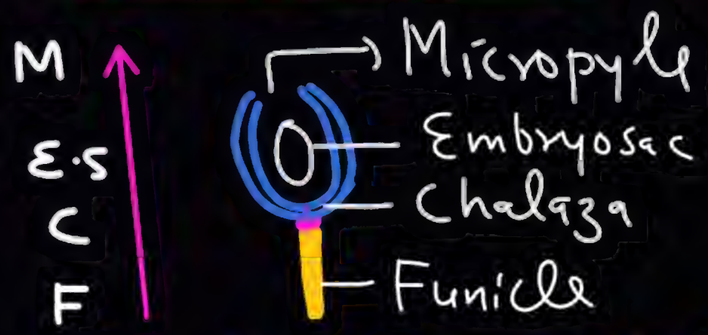
④ Chalaza - opposite to micropyle (Base of ovule)

⑤ Nucellus → Diploid cells, Any one cell Act as MMC (Megaspore mother cell/MMC)

Microsporangium → Sporogenous tissue, all cell PMC

Megasporangium → Nucellus, Any one cell MMC

Type of ovule



Erect ovule = Orthotropous

Anatropous ovule

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SANKALP NEET VEDANTU

sexual Reproduction in Flowering plants

lecture- 03

Botany

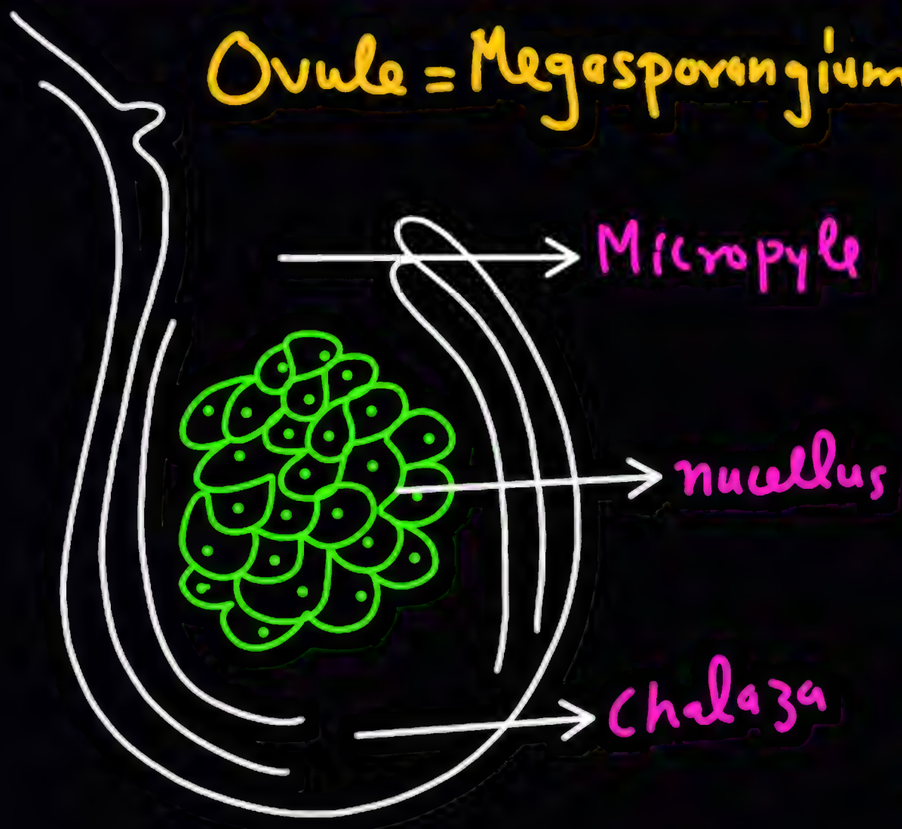
TARUN SIR

Today's Goal

→ Megasporogenesis

→ Pollination

Structure of ovule



Ovule = Megasporangium

Anatropous

[How Gamete (Egg cell) Formation occur in ovule

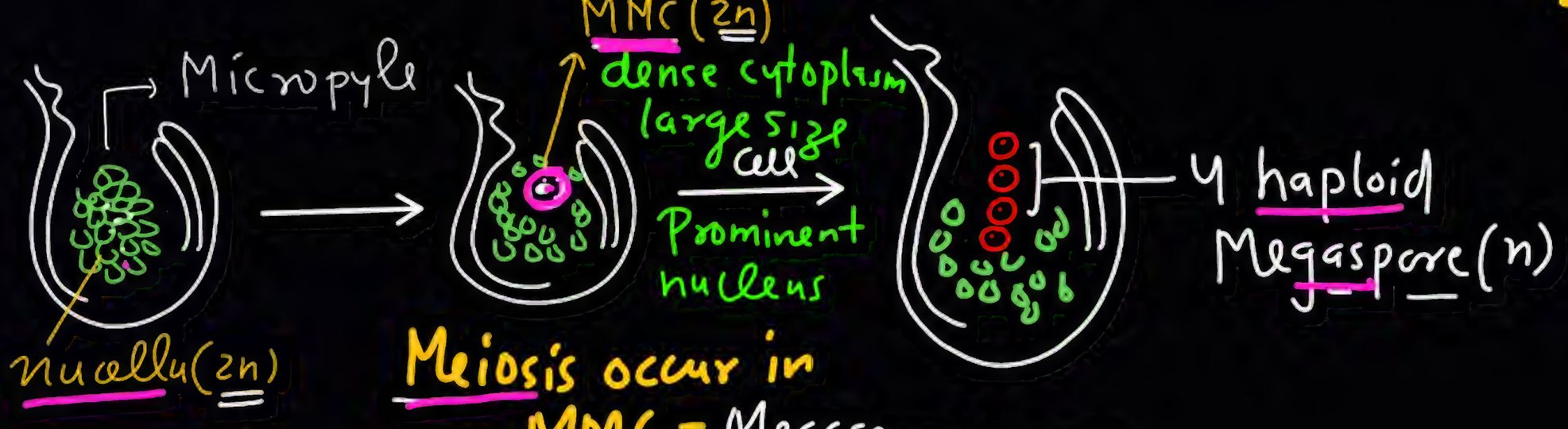
Two step

I Megasporogenesis

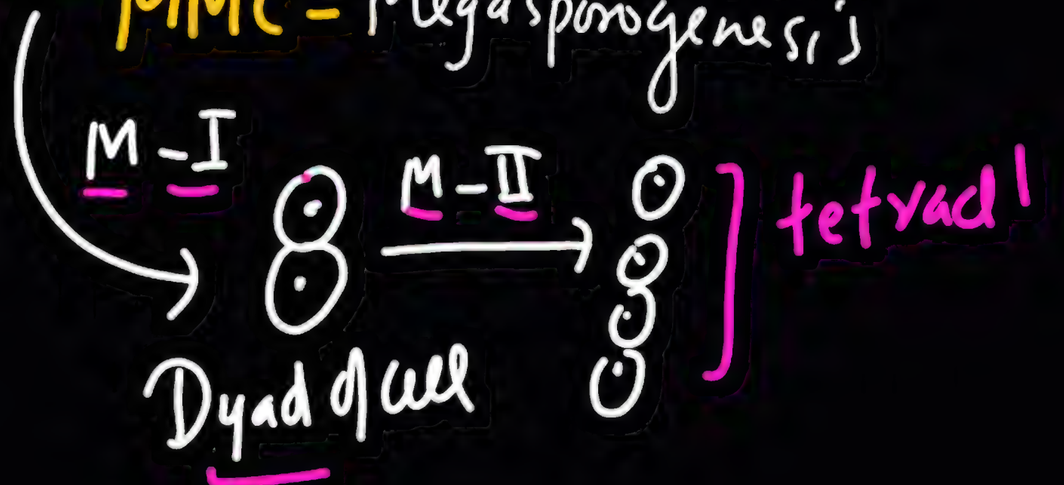
II Megaspore (n) develop into Female Gametophyte (n)

I megaspoyrogenesis – Inside ovule → Diploid tissue – nucellus

– Any one cell Close to micropyle → large size, dense cytoplasm → known as MMC (Megaspore mother cell)



Meiosis occur in MMC = Megasporogenesis



II Development of Female gametophyte from Megaspore

4 Megaspore (n)

3 Megaspore degenrate

Functional

n (Functional)

Mitosis in Functional Megaspore

2 nuclei stage

Two nuclei move to opposite pole

n n Vacuole

Mitosis

4 nuclei Stage

Mitosis

(Free nuclear Division no Cytokinesis)

Around Six nuclei

Wall Formation

Monosporic development – Out of 4 Megaspore Only one Functional

Micropyle end

Egg cell (n)

Synergids (n)

Embryo sac (Female gametophyte)

(7 cell) 8 nuclei

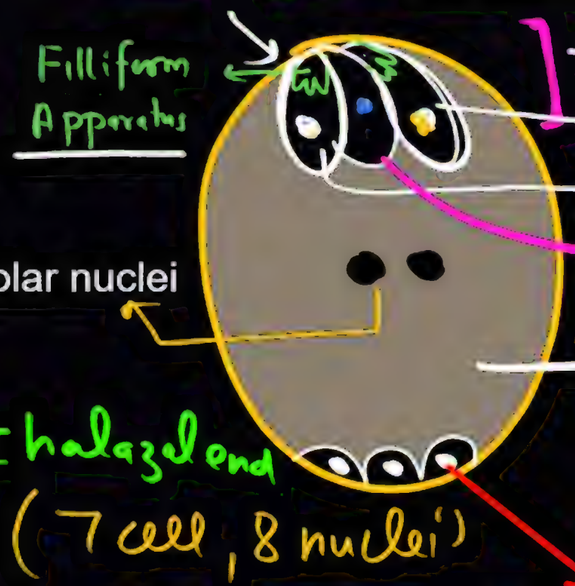
Central cell

Polar nuclei (n+n)

Antipodals (3) (n)

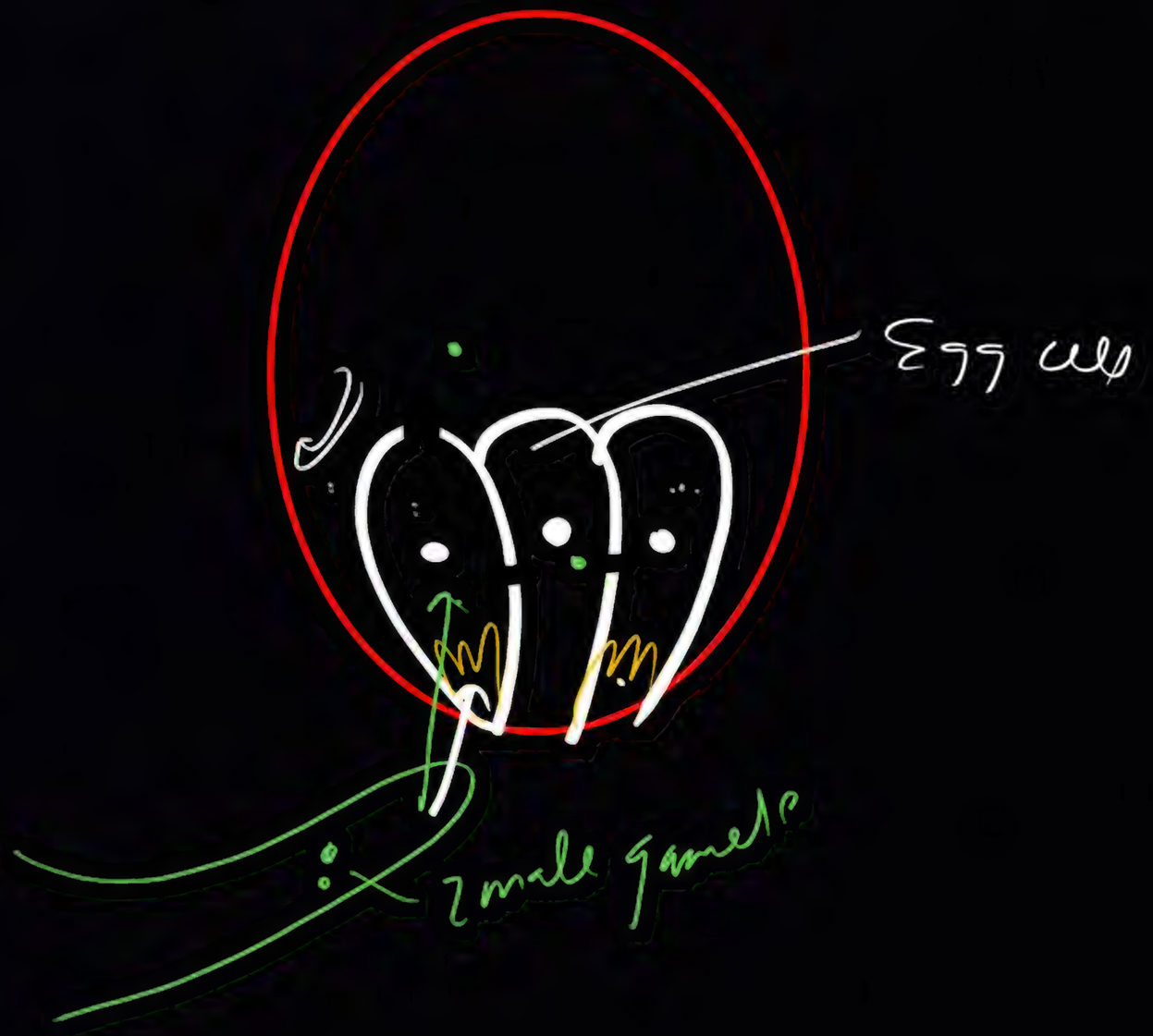
Chalazal end

Mature Female gametophyte



- **Egg Apparatus** – 2 synergids + 1 Eggcell (Gamete) (together help in Fertilization)
- **Synergids** – haploid cell & at micropyle
  Cellular thickening → **Filliform Apparatus** (guide Entry of pollen tube)
- **Eggcell** → Female gamete
- **Central cell** → largest cell, two **polar nuclei** (Present Below Egg Apparatus)
  ((later Form **Endosperm**)
- **Antipodal** (three in number)

note – 2 synergids & Egg cell (Plasmodesmata connection) present


Egg cell
2 male gamete

	Male gametophyte	Female gametophyte
name	Pollen grain (n)	Embryo sac (n)
cell number	2 cell | 3 cell	7 cell | 8 nuclei
gametes number	two male gamete	1 Female gamete (Egg cell)
One Meiosis	4 pollen grain	1 Embryosac (3 Megaspore degenrate)
location	Inside Microsporangium	→ Inside Megasporangium (Ovule)

X Ovule = Embryo sac

Inside ovule → Embryosac (n) → Female gametophyte.
(Megasporangium)

Pollination

- male gametophyte (Pollen) & Embryosac → Develop into Different location
- Any one has to move → It is male gametophyte (Pollen) move to Female gametophyte

definition :- It is transfer of **pollen** (From mature Anther) to **stigma**

Type of pollination (on the Basis of **Source** of pollen

self pollination

Pollen From same Flower / Flower of Same plant

→ Autogamy – A

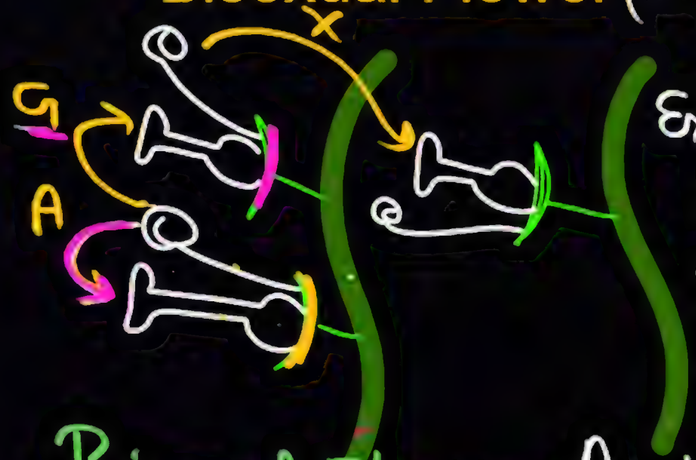
→ Geitonogamy – G

Cross pollination

Pollen come From Flower of Different plant

→ Xenogamy – X

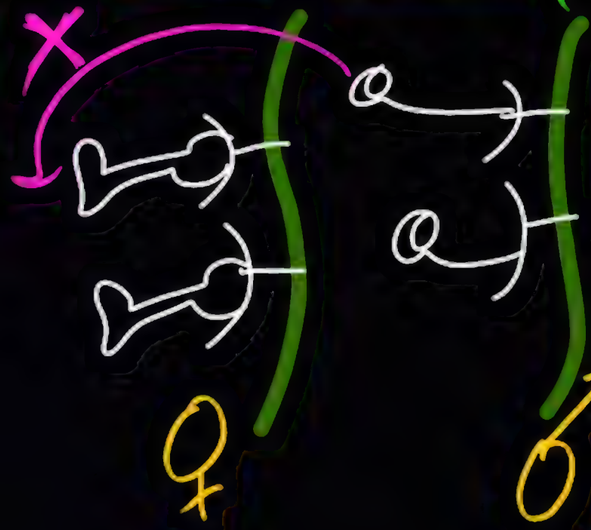
Bisexual Flower (Bisexual plant)



Ex- Pea
Hibiscus
Sweet potato

Bisexual Flower → Autogamy, Geitonogamy & Xenogamy occur

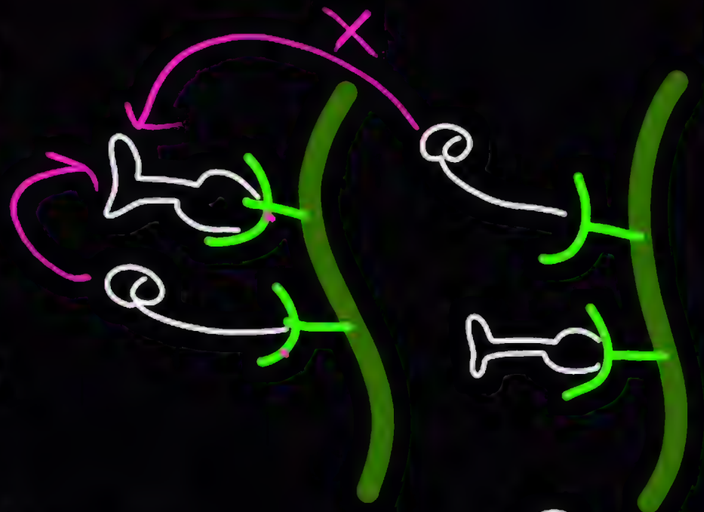
Unisexual Flower (Plant unisexual)



Ex- Papaya
- Date palm
- Vallisneria

Only Xenogamy

Unisexual Flower (Plant Bisexual)



- male & Female Flower on same plant

Ex- Maize, Coconut
Castor, Cucumber

Geitonogamy & Xenogamy occur

Q Castor show
(a) Autogamy (b) Xenogamy (c) Geitonogamy (d) Both b & c

Q Flower Bisexual show
(a) Auto (b) Geitono (c) Xeno (d) all

cleistogamous

Close Flower

- Flower not open to Expose stamen & pistil
- only Autogamy possible

Advantage:- No pollinator Require (Seed set assure)

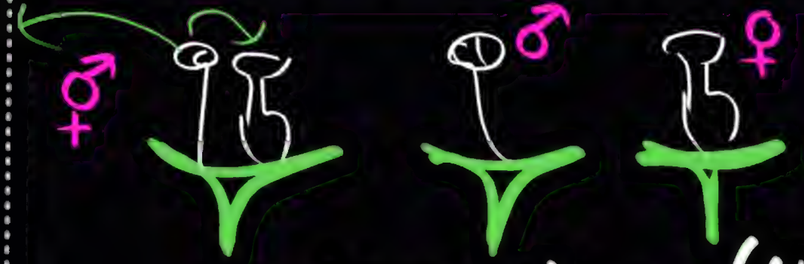
Disadvantage:- less variation)

note - Conditions in which cleistogamous Flowers Found →

(a) No pollinator → Desert ✓

Underground ✓

Chasmogamous



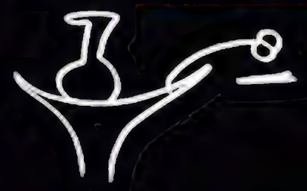
- open Flower (Unisexual or Bisexual)
- If Bisexual → Complete Autogamy is Rare (Pollen get tranfer to other Flower

Ex → Commelina, Viola, Oxalis → Both cleistogamous & Chasmogamous Flower]

Autogamy

- Tranfer of pollen on stigma of Same Flower

- Condition — ① Bisexual Flower
② Stigma & Anther position Close to Each other



(c) Anther maturity & Stigma Receptivity — Synchronise (एक साथ)

(d) Can occur in Both Cleistogamous & Chasmogamous (no need of pollinator)

Geitonogamy

Tranfer of pollen From Anther to stigma of Different Flower (But plant Same)

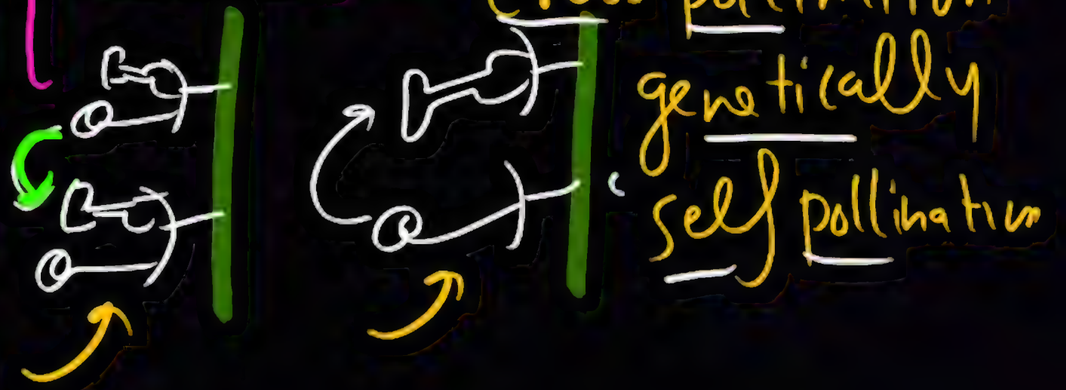
- Pollen coming From Genetically same plant

Condition :- (a) Chasmogamous Flower ✓

(b) Plant Bisexual ✓

(c) Pollinator need ✓

[Geitonogamy - Functionally Cross pollination genetically self pollination



Xenogamy – Transfer of pollen on stigma of Flower of Different plant (Same species)

Condition :- ① Pollinator Require
② Chasmogamous

Advantage – Maximum variation

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SANKALP NEET VEDANTU

sexual Reproduction in Flowering plants

lecture - 04

Botany

TARUN SIR

Today's Goal

→ Megasporogenesis

→ Pollination

Pollinating Agent

→ External Agency (Support) Require to transfer pollen – Geitonogamy & Xenogamy
Known as pollinating Agent

Two type of pollinating Agents

Abiotic (two) – non-living

(a) Wind – Wind pollination ✓ (Anemophily)

(b) Water – water pollination ✓ (Hydrophily)

Biotic (one → Animals) — Type

(a) Insect – Pollination — Entomophily

(b) Birds

(c) Bats

(d) Snails –

Q least pollination done By
(a) Wind (b) water (c) Insect (d) Animal

* Biotic pollination is more than Abiotic

* Abiotic – pollen move to stigma – By chance Event
(large number pollen Produce to Compensate large wastage)

Agents of pollination

Agents of Pollination : Plants use two abiotic (wind and water) and one biotic (animals) agents to achieve pollination. Majority of plants use biotic agents for pollination. Only a small proportion of plants use abiotic agents. Pollen grains coming in contact with the stigma is a chance factor in both wind and water pollination. To compensate for this uncertainties and associated loss of pollen grains, the flowers produce enormous amount of pollen when compared to the number of ovules available for pollination.

Wind pollination – Anemophily (Wind pollination is more than water pollination)

Features:- Wind pollinated Flowers

(a) Flower → Colourless, Odourless
nectarless

(b) Stamen → → Exerted (So that Pollen grain Release)

(c) Pollen → non-sticky, small, lightwt.
large in number

(d) Stigma → large & Feathery (capture pollen)

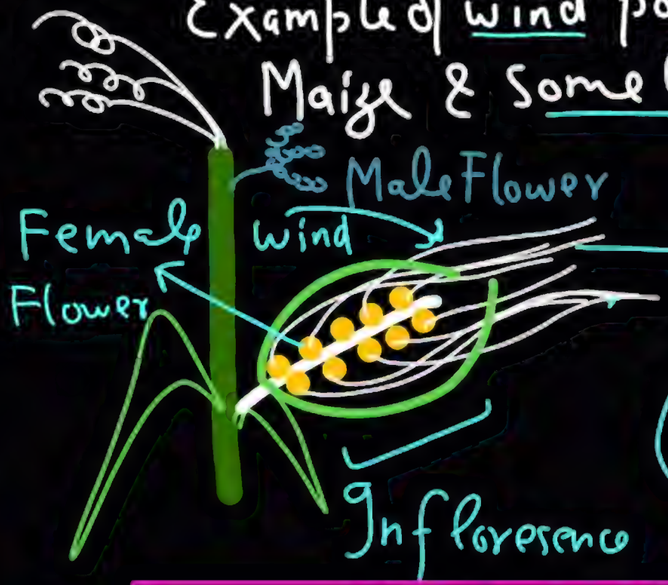
Ovary – Single ovule

ovary (many ovule)
large no of pollen on stigma

ovule

mono ovular
ovary – Wind pollination

Example of wind pollination
Maize & Some Grasses



note – If wind pollinated Flower
Small, present in Cluster
So that they can capture pollen

Wind pollination

Pollination by wind is more common amongst abiotic pollinations. Wind pollination also requires that the pollen grains are light and non-sticky so that they can be transported in wind currents. They often possess well-exposed stamens (so that the pollens are easily dispersed into wind currents, Figure 2.10) and large often-feathery stigma to easily trap air-borne pollen grains. Wind-pollinated flowers often have a single ovule in each ovary and numerous flowers packed into an inflorescence; a familiar example is the corn cob – the tassels you see are nothing but the stigma and style which wave in the wind to trap pollen grains. Wind-pollination is quite common in grasses.

Water pollination

Algae, Bryophyte and Pteridophyte → lower plants → Male gamete motile (Active move) – Pollination By water

Gymnosperm → Wind pollination

Plants Distribution limited (Due to water Pollination)

Angisperm → Mainly is Biotic ✓

Water Pollination is Rare (30 genera and mostly of Monocot – water Pollination)

Aquatic Angiosperm

Plant Is Aquatic → not pollinated By water

Flower well Above Surface of water

Pollination By → Insect & Wind

Ex – Water lily, Water hyacinth

Plant is Aquatic – Pollination By water

(a) Pollination on Surface

Ex – Vallisneria, Hydrilla (Fresh water)

(b) Pollination Under Water

Ex – Sea Grass (Zostera)

Water pollination

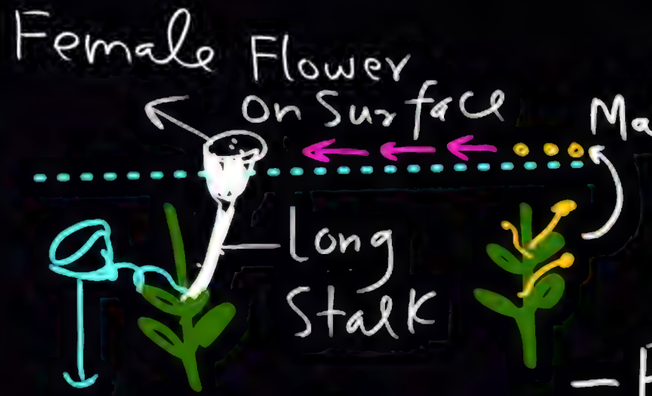
Pollination by water is quite rare in flowering plants and is limited to about 30 genera, mostly monocotyledons. As against this, you would recall that water is a regular mode of transport for the male gametes among the lower plant groups such as algae, bryophytes and pteridophytes. It is believed, particularly for some bryophytes and pteridophytes, that their distribution is limited because of the need for water for the transport of male gametes and fertilisation. Some

Aquatic plant

of male gametes and fertilisation. Some examples of water pollinated plants are *Vallisneria* and *Hydrilla* which grow in fresh water and several marine sea-grasses such as *Zostera*. Not all aquatic plants use water for pollination. In a majority of aquatic plants such as water hyacinth and water lily, the flowers emerge above the level of water and are pollinated by insects or wind as in most of the land

Vallisneria – Fresh water

Pollination on Surface of water – Epihydrophily



Male Flower / Pollen
Float passively
with water current
– Fall inside Female
Flower – Pollinate

Fertilize Flower
Underwater

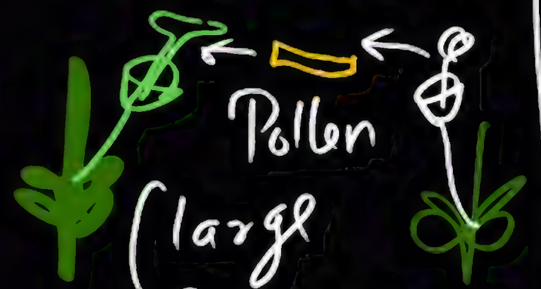
(Seed development – inside water)

(Sea Grass) Zostera – Marine

– Pollination under water
(Hypo hydrophily)

– Female Flower under water

Pollination occur Underwater
& male gamete – large & Ribbon Shape



Pollen
(large
Ribbon shape)

Pollen of water
Pollinated plant
have mucilage covering

↓

Pollen unwettable

↓

not sink

Fresh water plant

plants. In *Vallisneria*, the female flower reach the surface of water by the long stalk and the male flowers or pollen grains are released on to the surface of water. They are carried passively by water currents (Figure 2.11a); some of them eventually reach the female flowers and the stigma.

Marine plant

In another group of water pollinated plants such as seagrasses, female flowers remain submerged in water and the pollen grains are released inside the water. Pollen grains in many such species are long, ribbon like and they are carried passively inside the water; some of them reach the stigma and achieve pollination. In most of the water-pollinated species, pollen grains are protected from wetting by a mucilaginous covering.

Both wind and water pollinated flowers are not very colourful and do not produce nectar. *What would be the reason for this?*

Biotic Agents → main Biotic Agents - Animals

Insects – Bee, Butterfly, Flies, Beetle, wasp, Moth, Ants [Bee - Maximum Pollination]

Reptiles → lizards (Gecko lizards, Garden lizards)

Primates – Lemur

Arboreal Rodents

Bat pollinated	Bird pollinated
large size Flower	large size Flower
Dull colour Flower	Bright colour Flower
Strong odour/smell	Odourless

Insect pollination

Features → Nectar, Colour & Fragrance

→ Flower small - In cluster to make the conspicuous

→ Pollen grain - sticky

Insect Attract By → Colour & Fragrance

Some Flowers special Adaptation for insect

(a) Flies & Beetle → like Foul odour Flower

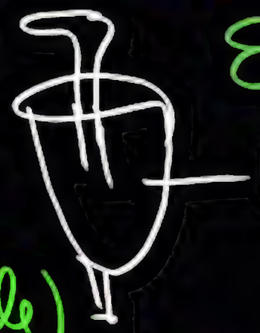
(b) Viola → Markings on petal (nectar guide)

Rewards For Pollinator

— To Ensure Regular visit of pollinator — Some Rewards Require

(a) Edible nectar ✓
(b) Edible Pollen ✓ } — Usual Rewards

(c) Safe Place For Egg laying



Flower — Space present insect can lay Egg

Ex — Amorphophallus plant

6 Ft tall

Space Egg lay

(d) Moth & Yucca plant

(Both can not complete its life cycle)

Moth → Egg lay inside ovarian cavity

Egg → larvae → come outside before Fruit develop

Benefit to plant — Pollination

Moth Benefit — Moth get place to lay Egg

Note — Some insect Eat nectar But not pollinate → Nectar Robbers

Outbreeding devices

→ Most Flower (Bisexual – Hermaphrodite) ⟶ Flower Bisexual Chances of Autogamy & Geitonogamy (Inbreeding)

→ This means Due to inbreeding ⟶ Harmful character Express ⟶ Known as Inbreeding depression

Aa X Aa (Inbreeding)

↓

AA Aa aa — Recessive gene Express

(Harmful character is Recessive)

All those method → Stop inbreeding known as Outbreeding Devices

Example of outbreeding devices

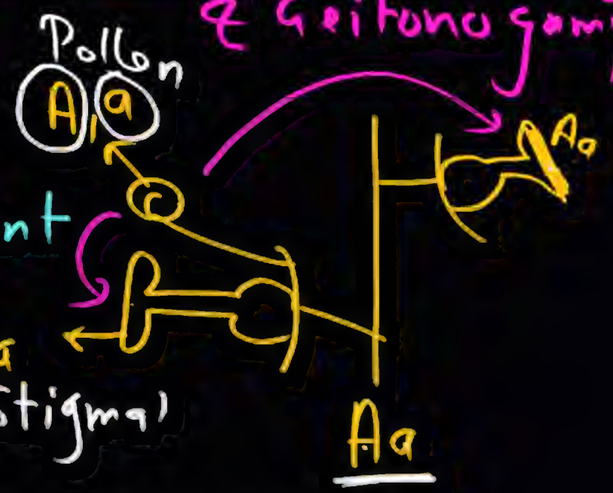
(a) In Flower – Anther maturity & Stigma Receptivity not synchronise (Dichogamy – term)

(b) Position of stigma & Anther not close to Each other

Herkogamy

(3) Unisexual Flower → Plant Bisexual (Ex- Castor & Maize) — Prevent Autogamy not Geitonogamy

→ Plant unisexual (Dioecy) (Ex - Papaya) → Prevent Both Autogamy & Geitonogamy



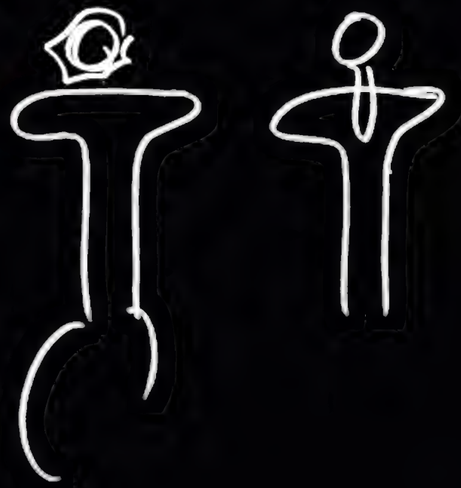
(4) Self incompatibility → Pollen From same plant is Rejected (Prevent Autogamy & Geitonogamy)

Compatible – Accepted

incompatible – Reject

Rejection occur By — (i) Pollen not Form tube

(ii) Pollen tube Growth Stop in Style



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SANKALP NEET VEDANTU

sexual Reproduction in Flowering plants

lecture - 05

Botany

TARUN SIR

Today's Goal

- Pollen pistil interaction
- Artificial hybridizatim
- Double Fertilization

I Pollen pistil interaction

meaning – all Events once pollen deposited on stigma & Entry of pollen tube inside ovule

Steps — (a) Pollen on stigma (Accept or Reject)

(b) Pollen germination

(3) Growth of pollen tube

(4) Entry of pollen tube inside ovule

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Pollen on stigma

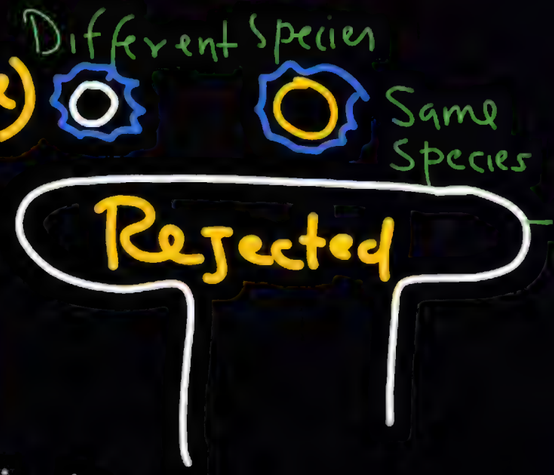
option I – Pollen is Rejected (wrong type pollen)

(a) Pollen self incompatible (same species)

(b) Pollen of Different species (Already incompatible)

Rejection occur By two ways — (a) Pollen not Allow to germinate

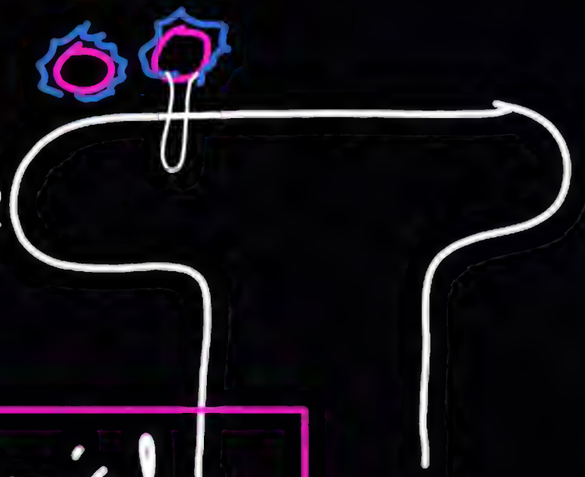
(b) pollen tube – Growth stop



option 2 **Pollen is Accepted** → Pollen right type (Same species, not self incompatible) Compatible

– Pollen germinate & Growth of pollen tube occur

(Post pollination Events)



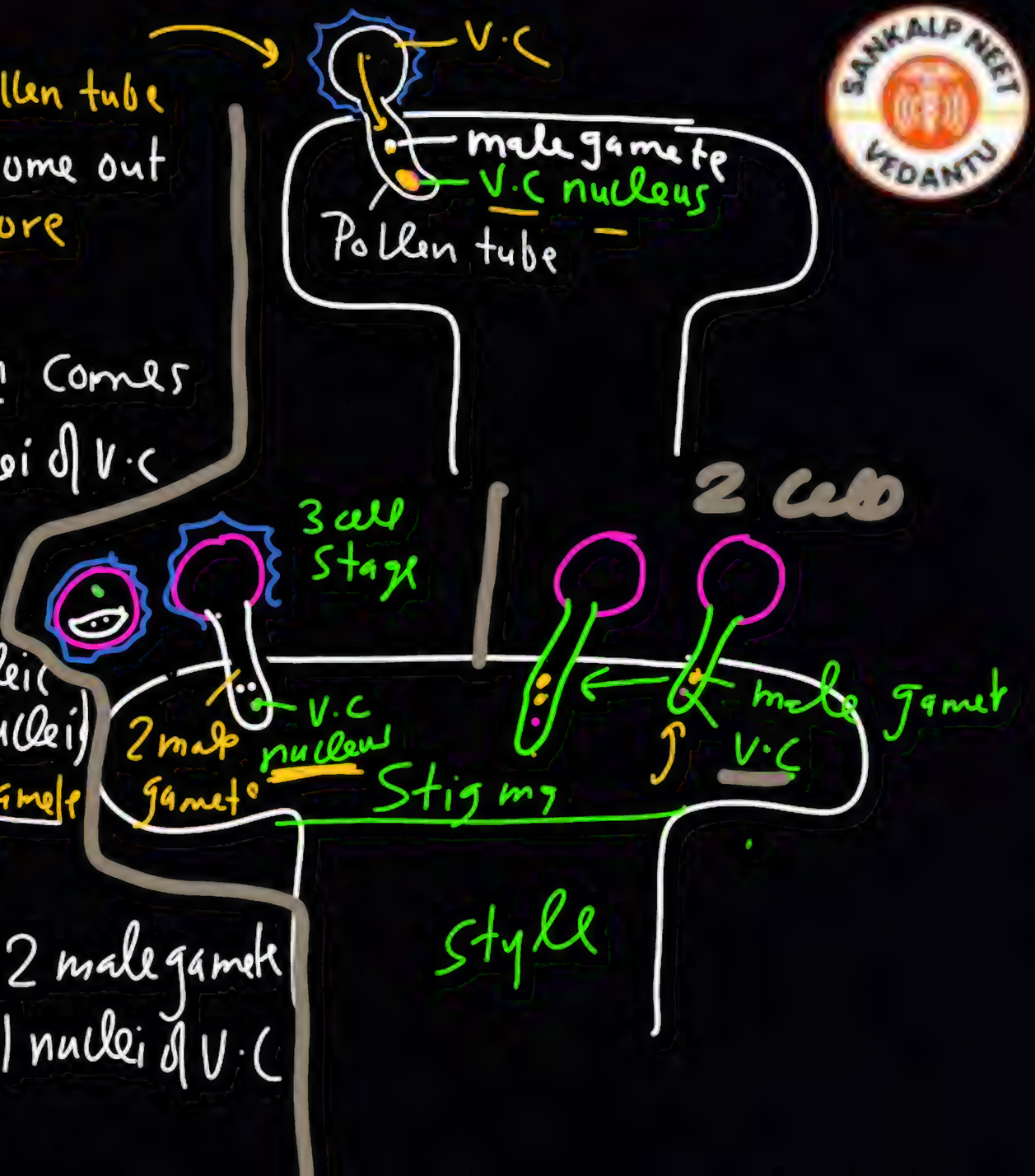
note – Pollen Acceptance & Rejection depend on chemical Rxn b/w Pollen & pistil

2. Pollen Accepted

- Once pollen Accepted on stigma → Pollen tube come out From Germ pore (Germinating Form pollen tube)
  (Boron help in pollen germination)
- In pollen tube → content of pollen grain comes
  (Pollen tube → have content → Vegetative cell cytoplasm, nuclei of V.C & male gamete)

Pollination → 2 cell stage (60% pollen) | Starting pollen tube two nuclei (V.C nuclei + G.C nuclei)
nucleus of G.C → Divide → two male gamete in stigma

Pollination → 3-cell stage (40%) → From starting → 2 male gamete + 1 nuclei of V.C



Growth of pollen tube

→ Pollen tube — produce Enzyme — to Digest it way through Stigma

→ Pollen tube grow in style

Style two type → (a) Solid Style (NEET-2016)

(transmission tissue through which pollen tube move

(b) Hollow style — Most Flowers style is hollow (So that pollen tube move Easily

→ Pollen tube grow in ovary → Enter into ovule towards micropylar End

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Entry of pollen tube

(Chemotropism)

(Porogamy)

- Pollen tube – in most Angiosperm – Enter From micropyle
- one of the synergid Start degenrating and Filliform Apparatus guide Entry of pollen tube

⇒ V.C nucleus – Role – Growth of pollen (now completed)
(this nucleus degenrate)

⇒ Pollen tube – Enter into one of the synergid
(Release Both male gamete in synergids)

Pollen-pistil Interaction : Pollination does not guarantee the transfer of the right type of pollen (compatible pollen of the same species as the stigma). Often, pollen of the wrong type, either from other species or from the same plant (if it is self-incompatible) also land on the stigma. The pistil has the ability to recognise the pollen, whether it is of the right type (compatible) or of the wrong type (incompatible). If it is of the right type,

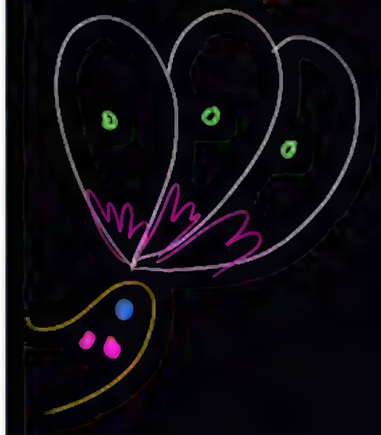
pistil has the ability to recognise the pollen, whether it is of the right type (compatible) or of the wrong type (incompatible). If it is of the right type, the pistil accepts the pollen and promotes post-pollination events that leads to fertilisation. If the pollen is of the wrong type, the pistil rejects the pollen by preventing pollen germination on the stigma or the pollen tube growth in the style. The ability of the pistil to recognise the pollen followed by its acceptance or rejection is the result of a continuous dialogue between pollen grain and the pistil. This dialogue is mediated by chemical components of the pollen interacting with those of the pistil. It is only in

components of the pollen interacting with those of the pistil. It is only in recent years that botanists have been able to identify some of the pollen and pistil components and the interactions leading to the recognition, followed by acceptance or rejection.

Post pollination Event

As mentioned earlier, following compatible pollination, the pollen grain germinates on the stigma to produce a pollen tube through one of the germ pores (Figure 2.12a). The contents of the pollen grain move into the pollen tube. Pollen tube grows through the tissues of the stigma and style and reaches the ovary (Figure 2.12b, c). You would recall that in some plants, pollen grains are shed at two-celled condition (a vegetative cell and a generative cell). In such plants, the generative cell divides and forms the two male gametes during the growth of pollen tube in the stigma. In plants which shed pollen in the three-celled condition, pollen tubes carry the two male gametes from the beginning. Pollen tube, after reaching

carry the two male gametes from the beginning. Pollen tube, after reaching the ovary, enters the ovule through the micropyle and then enters one of the synergids through the filiform apparatus (Figure 2.12d, e). Many recent studies have shown that filiform apparatus present at the micropylar part of the synergids guides the entry of pollen tube. All these events-from pollen deposition on the stigma until pollen tubes enter the ovule-are together referred to as pollen-pistil interaction. As pointed out earlier, pollen-pistil interaction is a dynamic process involving pollen recognition followed by promotion or inhibition of the pollen. The knowledge gained in this area would help the plant breeder in manipulating pollen-pistil interaction, even in incompatible pollinations, to get desired hybrids.



Artificial Hybridization

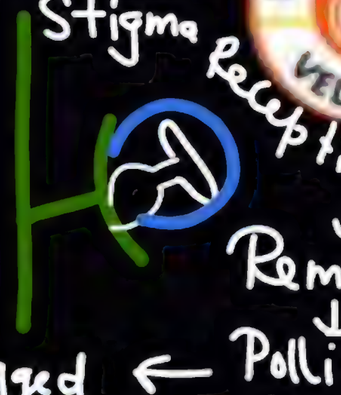
meaning – desired pollen transfer on Stigma By Artificial mean

Condition → It own Anther Remove (no self pollination)

Emasculation – Removal of Anther, Flower in Bud stage

Bagging — Stigma cover with Butter paper – to prevent Contamination From Undesired pollen

Bisexual Flower



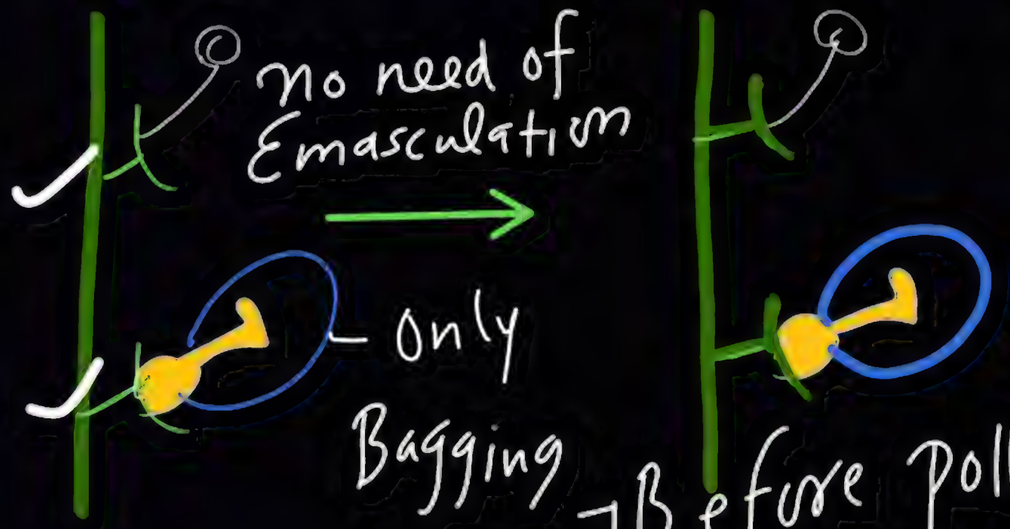
Stigma Receptive

Remove bag

Pollination

Rebagged

Unisexual Flower



no need of Emasculation

Only Bagging → Before pollination After pollination

If the female parent bears bisexual flowers, removal of anthers from the flower bud before the anther dehisces using a pair of forceps is necessary. This step is referred to as **emasculation**. Emasculated flowers have to be covered with a bag of suitable size, generally made up of butter paper, to prevent contamination of its stigma with unwanted pollen. This process is called **bagging**. When the stigma of bagged flower attains receptivity, mature pollen grains collected from anthers of the male parent are dusted on the stigma and the flowers are rebagged, and the fruits allowed to develop.

If the female parent produces unisexual flowers, there is no need for emasculation. The female flower buds are bagged before the flowers open. When the stigma becomes receptive, pollination is carried out using the desired pollen and the flower rebagged.

Double Fertilization

- Both male gamete Released By pollen tube in - one of the Synergids
- one male gamete move into central cell and other male gamete into Egg cell - By Plasmodesmata

triple Fusion - Three nuclei (2 polar nuclei and one male gamete) Fuse to Form triploid (3N) - nucleus - PEN

PEN → Primary Endosperm nucleus

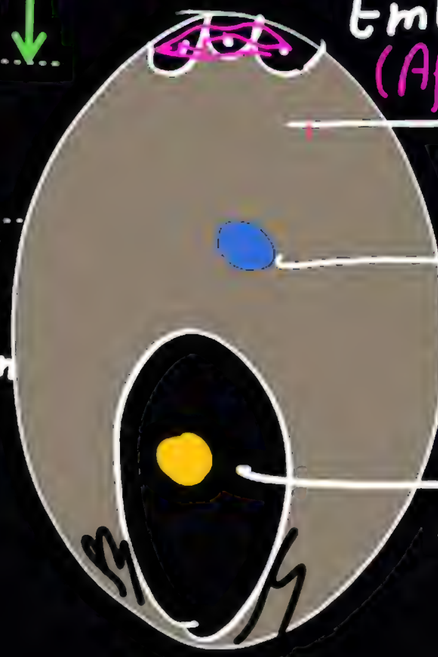
Central cell → now is PEC (Primary Endosperm cell)

Syngamy - nucleus of Egg cell Fuse with male gamete

Give Diploid cell → Zygote (2n)

Double Fertilization In one Embryosac two time Fertilization occur → triple Fusion & Syngamy

Only occur in Angiosperm



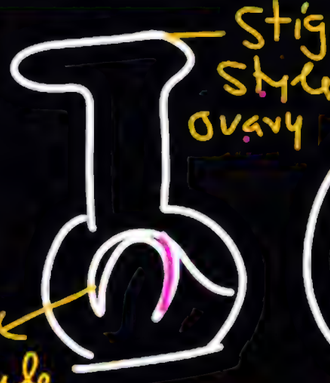
2.3 Double Fertilisation

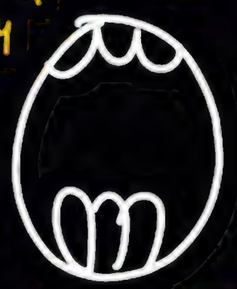
After entering one of the synergids, the pollen tube releases the two male gametes into the cytoplasm of the synergid. One of the male gametes moves towards the egg cell and fuses with its nucleus thus completing the **syngamy**. This results in the formation of a diploid cell, the **zygote.** The other male gamete moves towards the two polar nuclei located in the central cell and fuses with them to produce a triploid **primary endosperm nucleus** (PEN) (Figure 2.13a). As this involves the fusion of three haploid nuclei it is termed **triple fusion.** Since two types of fusions, syngamy and triple fusion take place in an embryo sac the phenomenon is termed **double fertilisation**, an event unique to flowering plants. The central cell after triple fusion becomes the **primary endosperm cell** (PEC) and develops into the **endosperm** while the zygote develops into an **embryo.**

Central cell (n+n) → triple
PEC (3n) (single cell) → Mitosis
Endosperm (3n) (many cells)

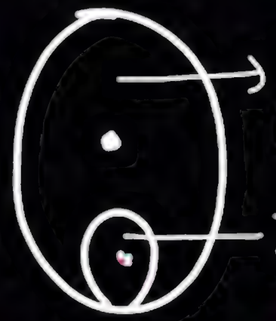
Ploidy of Different tissue

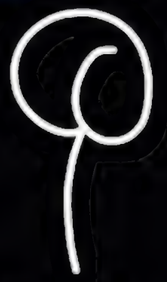
Plant is 2n





Embryosac
(all cells - n)
genetically same



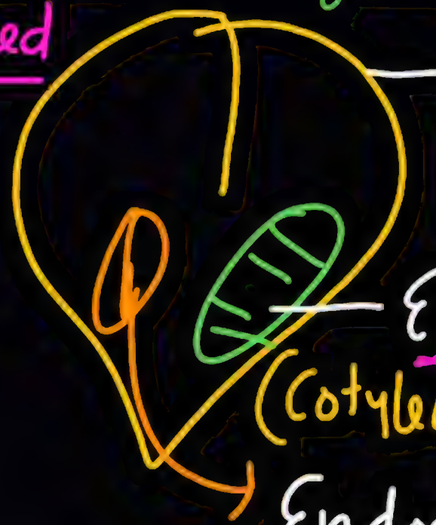


Anther (2n)
Filament (2n)

Epidermis, Endothecium
Middel layer
tapetum = 2n

Pollen grain
V.C → n
G.C → n
↳ two male gamete → n

Seed



Seed coat - 2n - Come From - Integument
Belong to - old Plant - old sporophyte

Embryo (2n) → Come From Zygote → After Fertilization → New sporophyte
(Cotyledon, Embryo axis
↳ Plumule, Radicle

Endosperm (3n) → new sporophyte (After Fertilization)

Q → tetraploid Female plant
hexa ploid male plant

♀ → 4n → egg cell → 2n

♂ → 6n → male gamete (3n)

3n → V.C
C.C

Polar nuclei 2n+2n

Antipodal	2n
Egg cell	2n
Seed coat	4n
Nucellus	4n
Integument	4n
Zygote	5n
PEC	2n+2n+3n = 7n
Cotyledon	5n
Plumule	5n

Q hexaploid Female plant → 6n

♂ Diploid male plant → 2n → gamete → n

Zygote → 3n + n = 4n

PEC → 3n + 3n + n → male gamete
(Polar nuclei)

Antipodal → 3n

Synergid, egg cell → 3n

Nucellus, stigma, ovule integument → 6n

Tapetum, Epidermis → 2n

V.C, C.C → n

- Zygote, Embryo, Cotyledon → 4n
- Endosperm, Aleurone layer → 7n

♀ — 8n

♂ → 6n

PEC ⟶ (4n) + (4n) + (3n) = 11n

Zygote → 4n + 3n ⇒ 7n

Female gamete

♀ 2n ⟶ n

♂ — 8n

PEC → n+n + 4n → 6n

Zygote → n + 4n → 5n

Seed coat → 2n

Post Fertilization Events

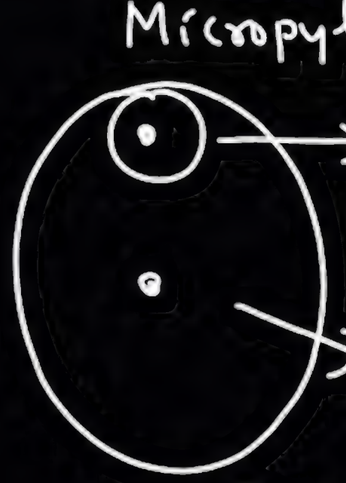
(a) PEC —develop into→ Endosperm

(b) Zygote —develop→ Embryo

(c) Integument → Seed coat

(d) Ovule → Seed

(e) Ovary → Fruit



Zygote present Mitosis (Nutrition Require) → Embryo

PEC → Divide First (Before division of Zygote)

Embryo → Food comp From Endosperm

2.4 Post-fertilisation : Structures and Events

Following double fertilisation, events of endosperm and embryo development, maturation of ovule(s) into seed(s) and ovary into fruit, are collectively termed **post-fertilisation events.**

Q which occur last

(a) triple Fusion

(b) Division of PEC

(c) Embryogeny ✓

(d) Double Fertilization

MANTHAN NEET 2025(1.0१२.0)

SANKALP NEET VEDANTU

sexual Reproduction in Flowering plants

lecture - 06

Botany

TARUN SIR

Today's Goal

Endosperm development

Embryo development

Seed & Fruit development

Apomixis

Post Fertilization Events

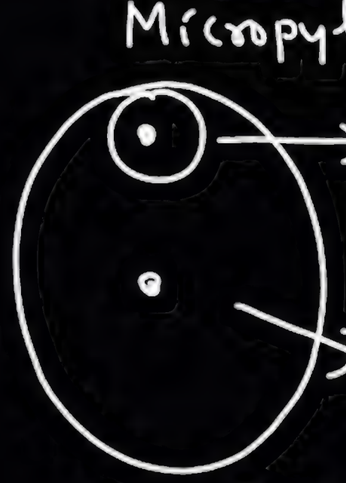
(a) PEC —develop into→ Endosperm

(b) Zygote —develop→ Embryo

(c) Integument → Seed coat

(d) Ovule → Seed

(e) Ovary → Fruit



Zygote present → Mitosis (Nutrition Require) → Embryo

PEC → Divide First (Befor division of Zygote)

Food comp From Endosperm

2.4 Post-fertilisation : Structures and Events

Following double fertilisation, events of endosperm and embryo development, maturation of ovule(s) into seed(s) and ovary into fruit, are collectively termed **post-fertilisation events.**

Q which occur last

(a) triple Fusion

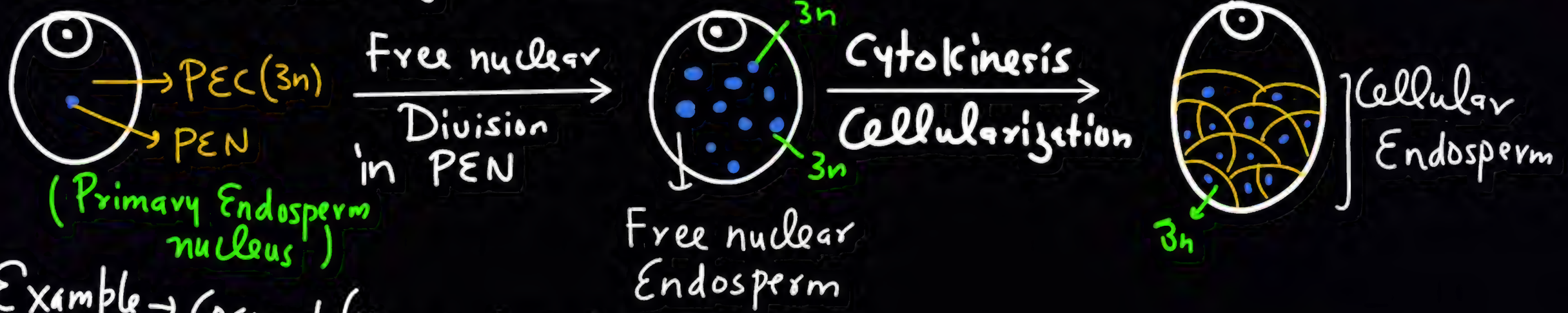
(b) Division of PEC

(c) Embryogeny ✓

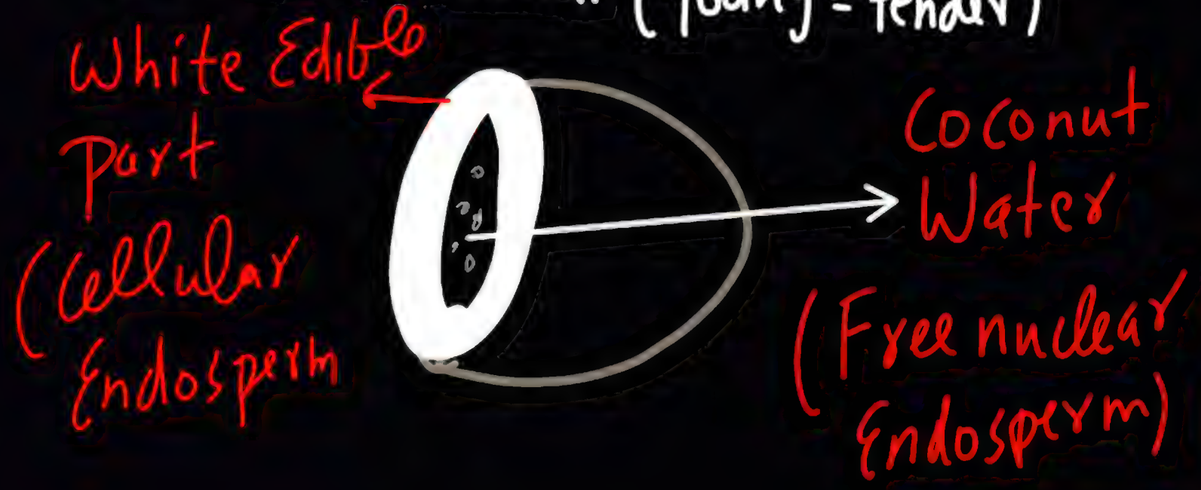
(d) Double Fertilization

Endosperm development

- Endosperm Give nutrition to developing Embryo ⟶ Some Amount of Endosperm Should Form before Zygote Divide



Example → Coconut (young - tender)



Endosperm development

Endosperm development precedes embryo development. *Why?* The primary endosperm cell divides repeatedly and forms a triploid endosperm tissue. The cells of this tissue are filled with reserve food materials and are used for the nutrition of the developing embryo. In the most common type of endosperm development, the PEN undergoes successive nuclear divisions to give rise to free nuclei. This stage of endosperm development is called free-nuclear endosperm. Subsequently cell wall formation occurs and the endosperm becomes cellular. The number of free nuclei formed before cellularisation varies greatly. The coconut water from tender coconut that you are familiar with is nothing but free-nuclear endosperm (made up of thousands of nuclei) and the surrounding white kernel is the cellular endosperm.

Erdospermous Non Endospermous seed

Zygote (2n)

→ Endosperm (3n)

Embryo → If all Food of Endosperm goes into Embryo

Food in cotyledon

Seed – non-Endospermous

Ex – Dicot seed

(Pea, Bean, Groundnut)

Endosperm

– Endosperm (Food Reserve) give nutrition to developing Embryo

– Aleurone-layer (Protein)

→ Rice White part (Endosperm)

If all Food of Endosperm not goes into Embryo

– Cotyledon Reduce

Seed – Endospermous

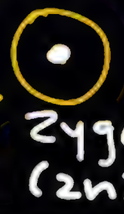
Ex – Monocot seed (Except – Orchid)

Wheat, Rice, Maize, Coconut

→ Castor – But Endospermous (Dicot)

Endosperm may either be completely consumed by the developing embryo (e.g., pea, groundnut, beans) before seed maturation or it may persist in the mature seed (e.g. castor and coconut) and be used up during seed germination. *Split open some seeds of castor, peas, beans, groundnut, fruit of coconut and look for the endosperm in each case. Find out whether the endosperm is persistent in cereals – wheat, rice and maize.*

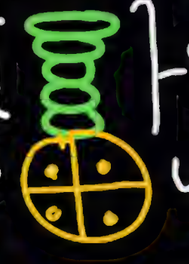
Embryo development



Undergo mitosis

(At Micropylar End)

2 cell stage



Proembryo

Globular Embryo

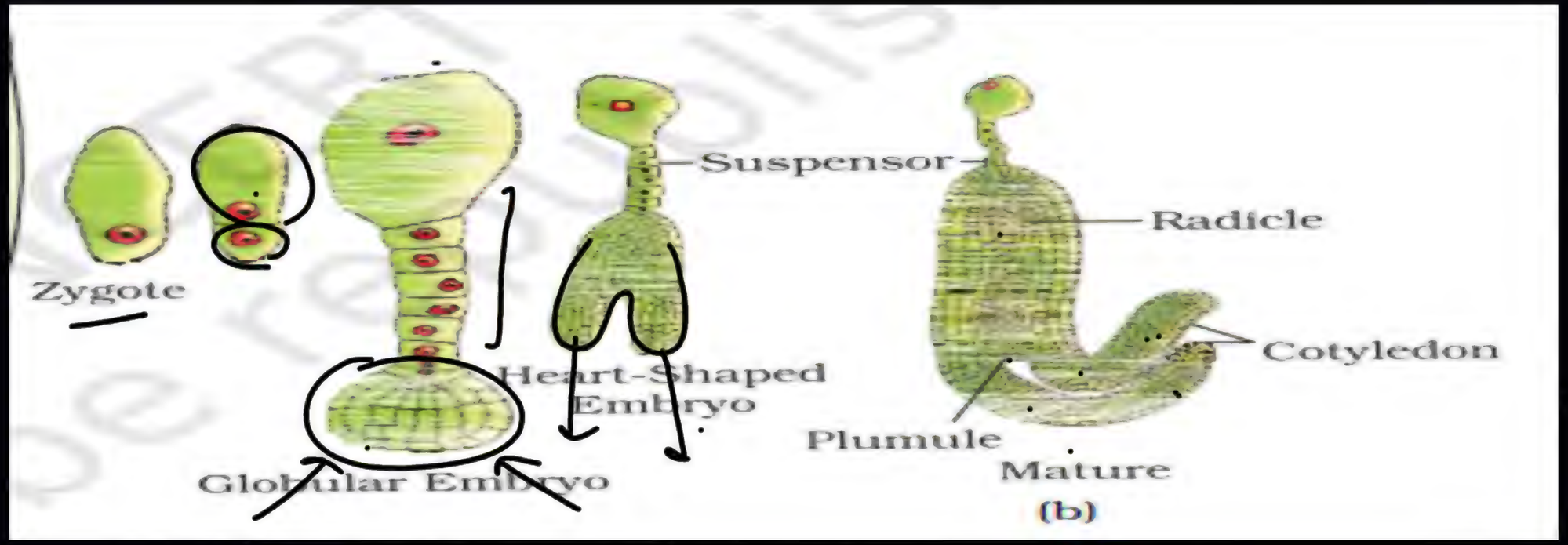
Heart shape Embryo

Embryo development → Embryogeny

Initial stage of Embryo development is similar in Dicot & Monocot

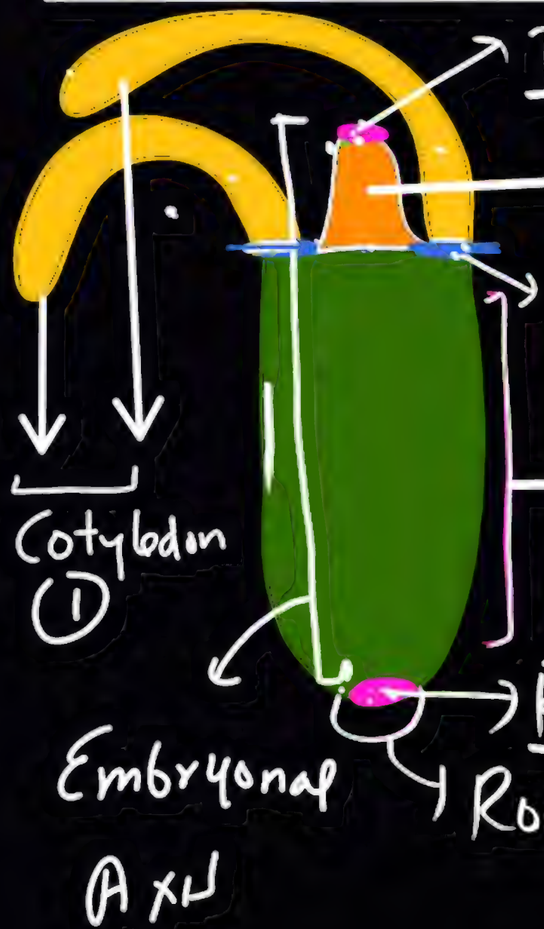
2.4.2 Embryo

Embryo develops at the micropylar end of the embryo sac where the zygote is situated. Most zygotes divide only after certain amount of endosperm is formed. This is an adaptation to provide assured nutrition to the developing embryo. Though the seeds differ greatly, the early stages of embryo development **(embryogeny)** are similar in both monocotyledons and dicotyledons. Figure 2.13 depicts the stages of embryogeny in a dicotyledonous embryo. The zygote gives rise to the **proembryo** and subsequently to the **globular**, **heart-shaped** and **mature embryo**.


Zygote
Suspensor
Heart-Shaped Embryo
Globular Embryo
Radicle
Cotyledon
Plumule
Mature
(b)

Dicot Embryo

- Cotyledon – Food Reserve ✓
- Embryonal Axis → (Epicotyl & Hypocotyl)



Plumule – Tip of Epicotyl → Gives shoot | stem

Epicotyl → part of Embryonal Axis Above the level of cotyledon

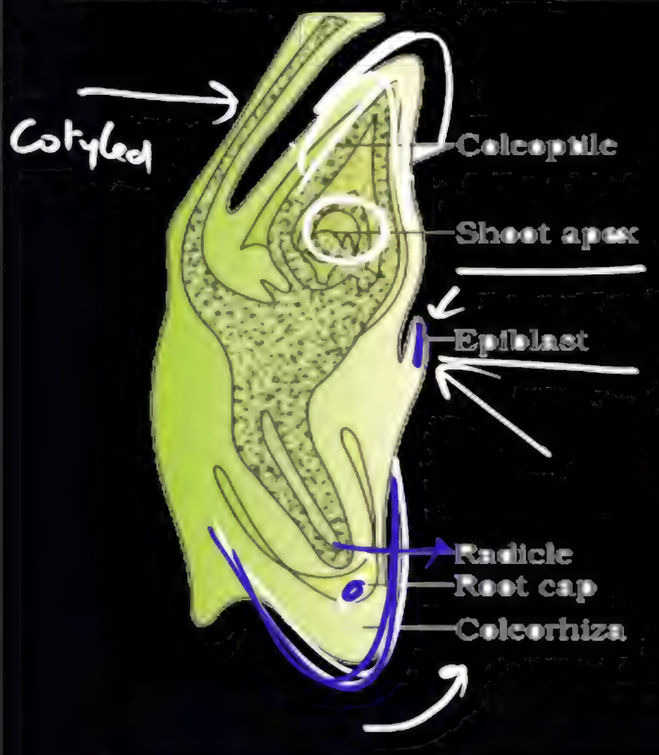
Level of cotyledon

Hypocotyl – Part of Embryonal Axis below the level of cotyledon

Radicle → tip of Hypocotyl – Gives Root

A typical dicotyledonous embryo (Figure 2.14a), consists of an **embryonal axis** and two **cotyledons.** The portion of embryonal axis above the level of cotyledons is the **epicotyl,** which terminates with the **plumule** or stem tip. The cylindrical portion below the level of cotyledons is **hypocotyl** that terminates at its lower end in the **radicle** or **root tip.** The root tip is covered with a **root cap.**

Monocot Embryo



Cotyledon – lateral (side) [Grass Family – Scutellum Shield shape]

Coleoptile – Hollow Foliar structure Surrround plumule

Plumule

Epicotyl – Part of Embryonal Axis Above level of Cotyledon

Epiblast – Remnant Cotyledon (बचा हुआ)

hypocotyl –

Radicle

Root cap

Coleorhizae – Sheath Cover Radicle

In Grass Family → Cotyledon Known as Scutellum

& Grasses have coleoptile & coleorhizae present

Embryos of monocotyledons (Figure 2.14 b) possess only one cotyledon. In the grass family the cotyledon is called **scutellum** that is situated towards one side (lateral) of the embryonal axis. At its lower end, the embryonal axis has the radical and root cap enclosed in an undifferentiated sheath called **coleorrhiza.** The portion of the embryonal axis above the level of attachment of scutellum is the epicotyl. Epicotyl has a shoot apex and a few leaf primordia enclosed in a hollow foliar structure, the **coleoptile.**

Seed

definition → Fertilized ovule is seed

Structure of seed —— ① Seed Coat → derive From integument
(On seed coat – Scar – Hilum
Small pore → Micropyle)

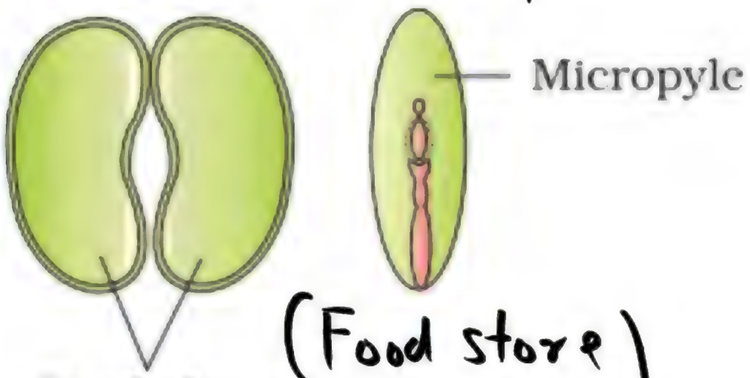
② Embryo → Cotyledon → Food Reserve For seed germination
→ Embryonal Axis → Epicotyl & hypocotyl

③ Endosperm – not present in all seed

Endosperm present → Endospermous / Albuminous

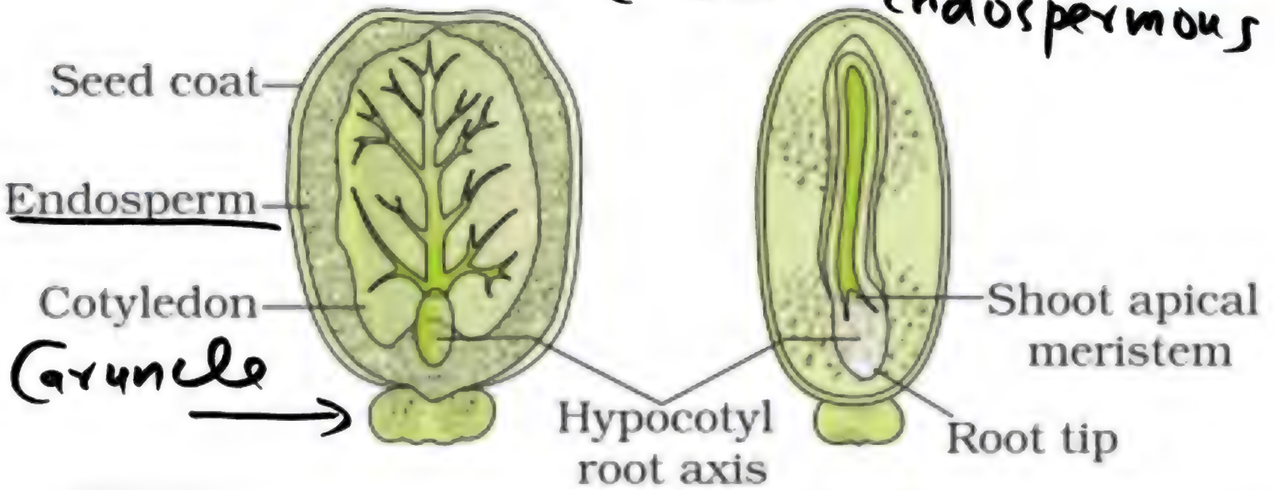
Endosperm Absent → Non Endospermous / Ex-Albuminous

Pea – non-Endospermous

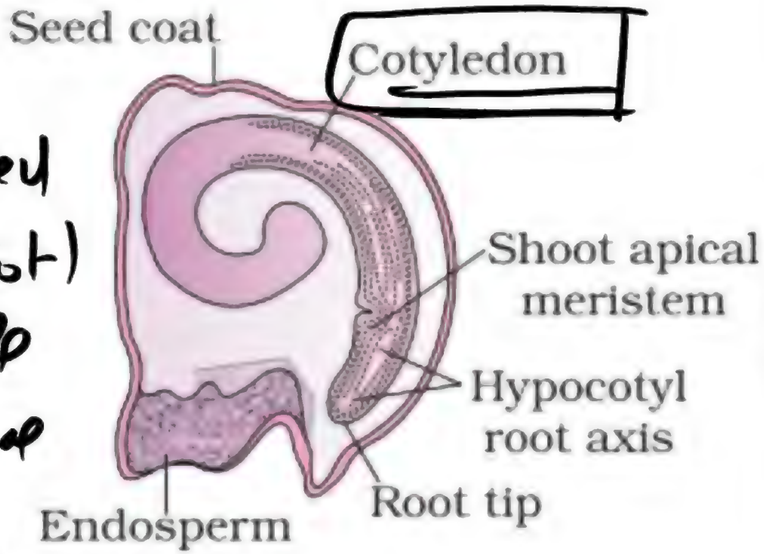


(Food store in cotyledon)

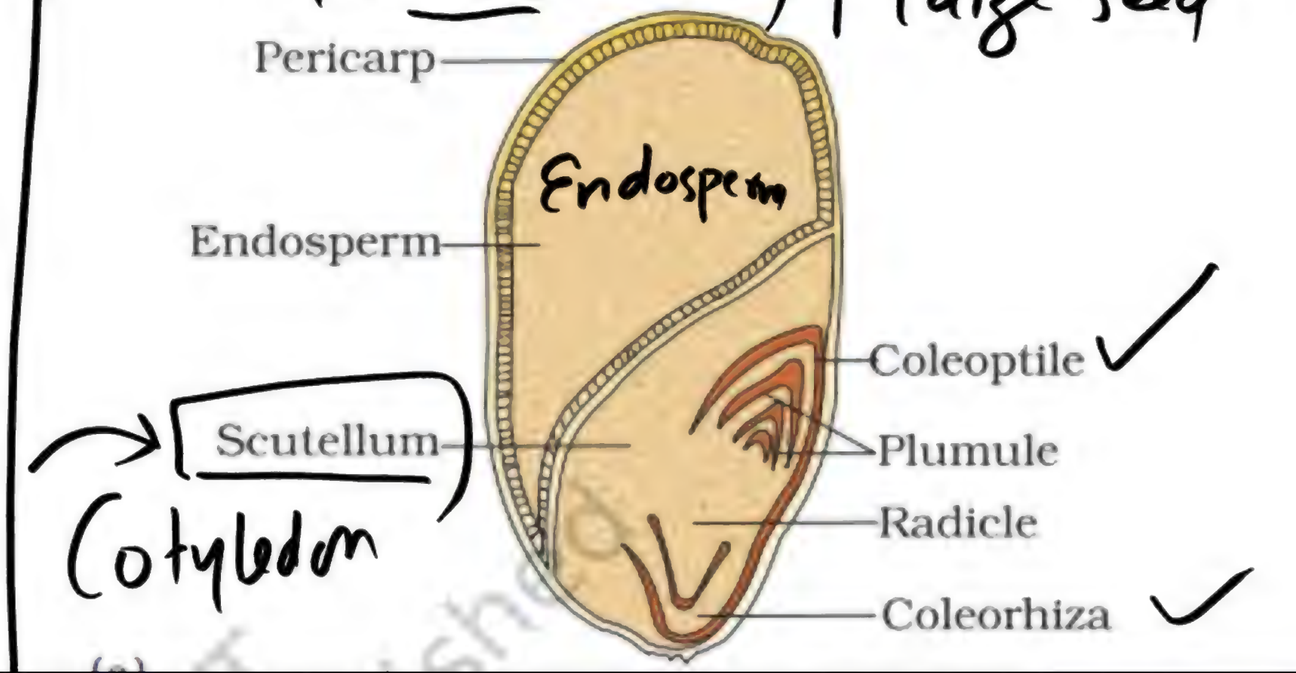
Castor – Endospermous



Onion seed (Monocot)
no coleoptile
Coleorhiza
no-Scutellum



Grasses → Maize seed

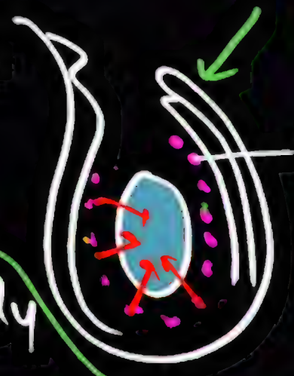


Cotyledon

Perisperm — In some seed → nucellus is persistent

– Persistent nucellus form a layer – Perisperm

Ex – Black pepper
Sugar beet



nucellus (Used up) ↓ Provide nutrition to Embryo sac

Q Perisperm is Genetically Similar to
(a) Plumule (b) Radicle (c) tapetum (d) seed coat

Mature seeds may be **non-albuminous** or **ex-albuminous**. Non-albuminous seeds have no residual endosperm as it is completely consumed during embryo development (e.g., pea, groundnut). Albuminous seeds retain a part of endosperm as it is not completely used up during embryo development (e.g., wheat, maize, barley, castor). Occasionally, in some seeds such as black pepper and beet, remnants of nucellus are also persistent. This residual, persistent nucellus is the **perisperm.**

seed development

→ Ovule develop into seed

Changes ⟶ (a) Integument From Seed coat

(b) Embryo Fully mature

(c) Endosperm may or not present

(d) water content ⟶ 10-15% of wt

(Seed metabolically Inactive ⟶ Enter into inactive Stage - dormancy

Seed germination → Condition → (a) Moisture

(b) Adequate temp

(c) Oxygen

Enter From Milropyle

seed development

Integuments of ovules harden as tough protective seed coats (Figure 2.15a). The micropyle remains as a small pore in the seed coat. This facilitates entry of oxygen and water into the seed during germination. As the seed matures, its water content is reduced and seeds become relatively dry (10-15 per cent moisture by mass). The general metabolic activity of the embryo slows down. The embryo may enter a state of inactivity called **dormancy**, or if favourable conditions are available (adequate moisture, oxygen and suitable temperature), they germinate.

Advantage of Seed

(a) Seed is product of Sexual Reproduction —— Give Variation

(b) Hard seed coat → protect Embryo

(c) In life cycle of Angiosperm — Stages — Pollination, Fertilization, Embryo development
Seed germination

(Seed germination → dependent on water ⟶ Seed can Search Favorable Condition

(d) Seed have Food Reserve → For initial development

(e) Seed two property → Dehydration, Dormancy } Basis For Agriculture)

(Due to which Farmers can Store seed, transport & Use in next Season

Seeds offer several advantages to angiosperms. Firstly, since reproductive processes such as pollination and fertilisation are independent of water, seed formation is more dependable. Also seeds have better adaptive strategies for dispersal to new habitats and help the species to colonise in other areas. As they have sufficient food reserves, young

Advantage of Seed

to colonise in other areas. As they have sufficient food reserves, young seedlings are nourished until they are capable of photosynthesis on their own. The hard seed coat provides protection to the young embryo. Being products of sexual reproduction, they generate new genetic combinations leading to variations.

Seed is the basis of our agriculture. Dehydration and dormancy of mature seeds are crucial for storage of seeds which can be used as food throughout the year and also to raise crop in the next season. Can you imagine agriculture in the absence of seeds, or in the presence of seeds which germinate straight away soon after formation and cannot be stored?

viability of seed

- maximum time period ⟶ Seed can germinate After maturation

Some seeds — short viability & Some species long Viability

Long viability of seed

Ex- ① Lupinus Arcticus ⟶ Found Artic tundra → 10,000 year old Seed (low temp)
(germinate & Flower)

② Phoenix dactylifera (Date palm) ⟶ Excavated Near King Herod's palace (dead sea) (Salt Excess)

↳ Seed — 2000 year old

↓

[Seed unable to Absorb Water]

How long do the seeds remain alive after they are dispersed? This period again varies greatly. In a few species the seeds lose viability within a few months. Seeds of a large number of species live for several years. Some seeds can remain alive for hundreds of years. There are several records of very old yet viable seeds. The oldest is that of a lupine, *Lupinus arcticus* excavated from Arctic Tundra. The seed germinated and flowered after an estimated record of 10,000 years of dormancy. A recent record of 2000 years old viable seed is of the date palm, *Phoenix dactylifera* discovered during the archeological excavation at King Herod's palace near the Dead Sea.

large number of seed

Plants can produce large no. of seed →

1 plant — 100 Flower
Each Flower = 10 pistil
Each pistil → 200 ovule

100 X 10 X 20

⇉ 20000 Seed

Ex- Orchid
- → Ficus (Banyan, peepal)
- → Orobanche
- → Striga

Orobanche, Striga — Parasitic Plants

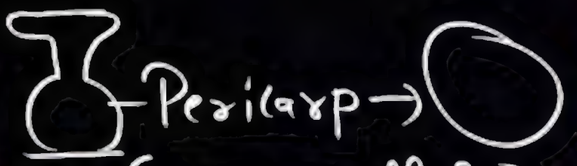
Four Examples – large no. of tiny Seeds

near the Dead Sea.

After completing a brief account of sexual reproduction of flowering plants it would be worth attempting to comprehend the enormous reproductive capacity of some flowering plants by asking the following questions: How many eggs are present in an embryo sac? How many embryo sacs are present in an ovule? How many ovules are present in an ovary? How many ovaries are present in a typical flower? How many flowers are present on a tree? And so on...

Can you think of some plants in which fruits contain very large number of seeds. Orchid fruits are one such category and each fruit contain thousands of tiny seeds. Similar is the case in fruits of some parasitic species such as Orobanche and Striga. Have you seen a tiny seed of Ficus? How large is the tree of Ficus developed from that tiny seed. How many billions of seeds does each Ficus tree produce? Can you imagine any other example in which such a tiny structure can produce such a large biomass over the years?

Fruits — Ripened Fertilize ovary — Fruit



(Ovary wall & Fruit wall)

Type of Fruit

(a) True Fruit – develop From ovary

(b) False Fruit – thalamus involve in Fruit Formation

Ex- Apple, Cashew, Strawberry

↓

False (Fleshy)

(c) Parthenocarpic — Seed less Fruit

Ex- Banana

(note- Auxin induce parthenocarpy

False Fruit | Achene | Aggregate Fruit (develop From Apocarpus)

Type of Fruit

Dry – Pericarp not Differentiate into layers

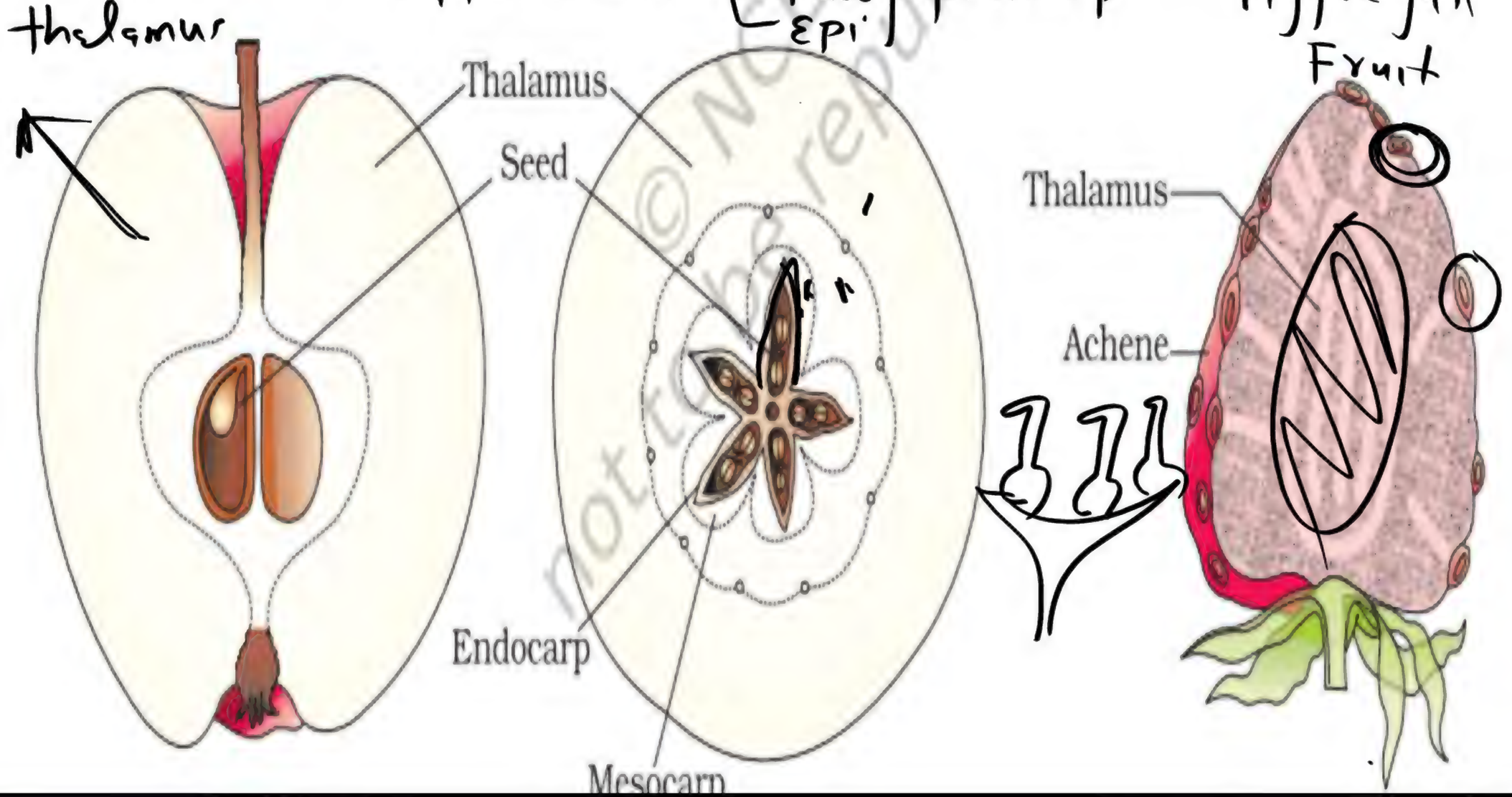
Ex- Pea, Mustard

Fleshy – Pericarp Divide into three layers (→ Epi, Endo, Meso)

Ex- Mango, Guava, Orange

Apple – Fleshy – Endo / Meso / Epi } Pericarp

Aggregate Fruit



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Apomixis

→ Fruit development – without Fertilization ⟶ Parthenocarpy

→ Seed development (without Fertilization)
↳ Embryo development (without Fertilization)

⟶ Apomixis
(type of Asexual Reproduction mimic Sexual Reproduction By Forming seed

Feature ⟶ (a) No Fertilization
(b) Seed Form
(c) Seed Form is Genetically same to Parent plant

How Apomixis occur

Egg cell (Diploid) —Mitosis→ Embryo (2n)

(Form without Meiosis)

(2n) nucellus (2n) → Divide → Enter into Embryosac → Form Embryo

Ex- Citrus & Mango

— More than one Embryo Can Form

Apomixis Example
- Some Grasses ✓
- Some Member of Asteraceae ✓
- Citrus, Mango ✓

Polyembryony → 9n orange - one seed have more than Embryo

(One seed - More than one Embryo)

(But only one Embryo develop into plant)

2.5 Apomixis and Polyembryony

Although seeds, in general are the products of fertilisation, a few flowering plants such as some species of *Asteraceae* and grasses, have evolved a special mechanism, to produce seeds without fertilisation, called **apomixis.** *What is fruit production without fertilisation called?* Thus, apomixis is a form of asexual reproduction that mimics sexual reproduction. There are several ways of development of apomictic seeds. In some species, the diploid egg cell is formed without reduction division and develops into the embryo without fertilisation. More often, as in many *Citrus* and *Mango*

Polyembryony

varieties some of the nucellar cells surrounding the embryo sac start dividing, protrude into the embryo sac and develop into the embryos. In such species each ovule contains many embryos. Occurrence of more than one embryo in a seed is referred to as **polyembryony**. *Take out some seeds of orange and squeeze them. Observe the many embryos of different sizes and shapes from each seed. Count the number of embryos in each seed. What would be the genetic nature of apomictic embryos? Can they be called clones?*

Hybrid seed

two plant → character combing in Hybrid seed → Advantage - Production high

Plant Form → Seed develop (Characters no more together → Farmer need to buy seed Again

Hybrid Seed → Plant Grow (Some changes) → Plant Apomictic Seed — Genetically Same to Hybrid seed → Farmer need not to Buy now Seed Again

A x a → (Aa) Hybrid → Plant Sexual → Apomixis → (Aa) Apomictic seed

(AA) (aa)

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SANKALP NEET VEDANTU

Principle of inheritance and variation

lecture – 01

Botany

TARUN SIR

Class 12th

- SRFP → 3-4Q

- Principles of inheritance ⟶ 5-6 ⟶ 9
- Molecular Basis of inheritance → 6-7Q → 10

Topics

introduction-gene,allele ,chromosome ,haploid,diploid

Mendelian principle- hybridisation experiment,result,law and cross

Gene interaction- incomplete dominance,co-dominance and muliple allele, polygenic inhritance

DOPA prime-1

Chromosomal theory, linkage and sex determination

Dopa prime-2

Mutation,pedigree analysis , genetic disroder

Dopa prime-3

we need to understand

Gene ✓

allele ✓

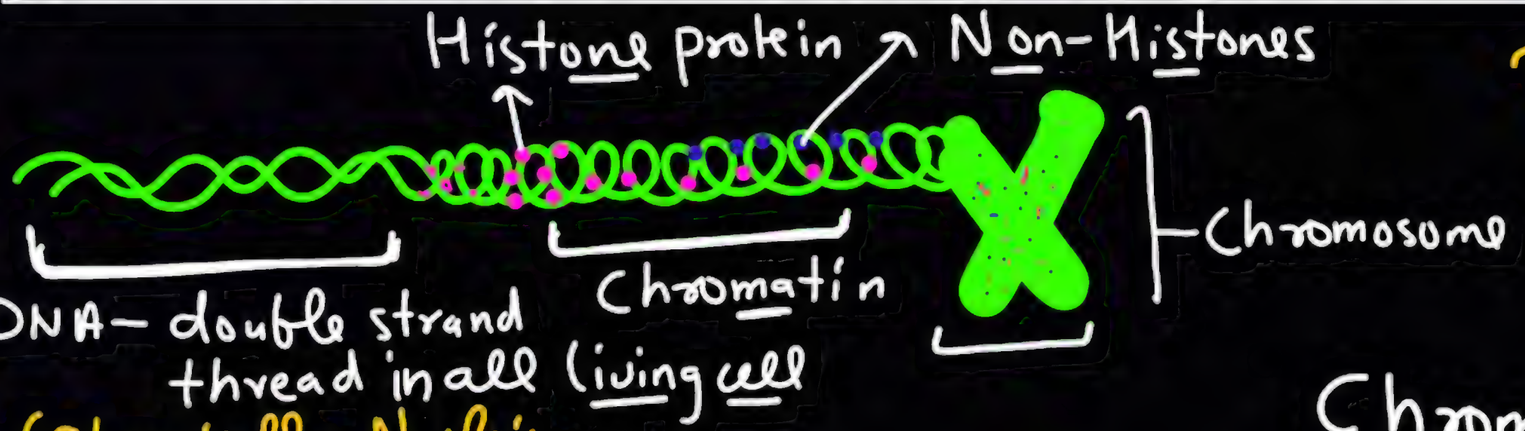
chromosome,chromatin

genome,genotype,gene pool,phenotype

concept of character, ✓

concept of locus ✓

DNA ,chromatin and chromosome



→ DNA – double strand thread in all living cell

→ (Chemically – Nucleic Acid) ✓

→ Charge → – ve ✓

Chromatin → DNA, Protein (Histones, non-Histones) RNA

→ DNA is condensed Form is Chromatin

note – Chromatin & Chromosome in Eukaryotes

– Prokaryote condense DNA is nucleoid

Chromosome – Chromatin Further Condense, During cell Division ✓

Q1 Which is precent in E. coli & Yeast Both

(a) DNA (b) Chromatin

(c) Chromosome (d) all

* In all living cell DNA is Double stranded, it is Genetic material (Gene present)
* In Eukaryotic cell & prokaryotic cell – Both cell show condensation of DNA
* Eukaryotes → DNA → Chromatin → chromosome [Histones present]
* Prokaryotes → DNA condensed to Form nucleoid [Histones Absent] ✓
* Eukaryotes DNA present → At two places → nucleus
  → organelle (Chloroplast ✓ Mitochondria ✓)
* Prokaryotes DNA present → only in cytoplasm – As nucleoid & Plasmid
* DNA is → Double Strand
  - linear DNA → Eukaryotic cell nucleus
  - circular DNA → Prokaryotes Nucleoid, Plasmid
    Eukaryotes organelle

Q2 DNA of Methanogen not true

(a) Double strand (b) have Gene (c) Circular (d) linear

Q3 Which is linear DNA ⟶ It present in nucleus of Eukaryotes

(a) DNA of RBC (b) DNA of nucleus of WBC

(c) DNA of Mitochondria (organelle) (d) DNA of Chloroplast

Concept of gene

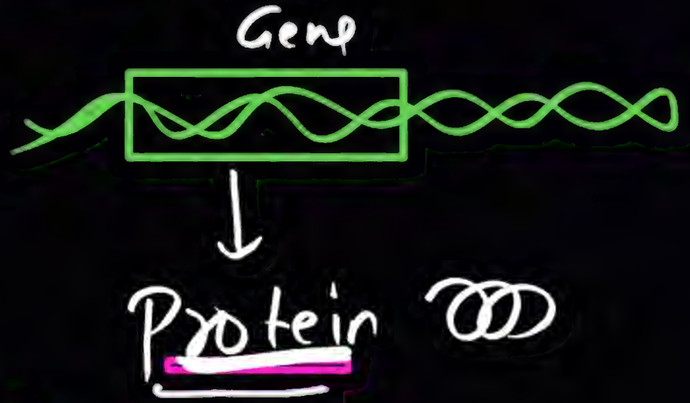
Gene — two type definition

Acc. to Mendelian Genetics → Gene is Unit of inheritance
↳ Smallest Unit → which control Some trait/character

Gene ⟶ Black eye colour

Molecular Genetics → Gene is Segment on DNA which Form one type of protein

DNA - Structure
Gene ⟶ Segment of DNA
Some Function perform



Note - In all living cell → Gene is made up of DNA

DNA - Structure
Gene - Function

XY

Gene = Junk DNA / non-coding DNA

Genetic material ⟶ Sum total of all gene

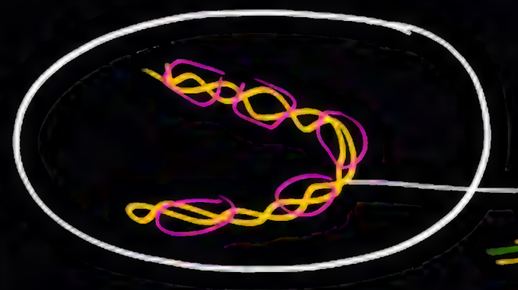
Genome → haploid set of chromosome

Bacteria → Genome & Genetic material is Same

Genotype → Pea plant

Tt — Genotype

(Characters By Gene symbol Represent)



Q Bacterial DNA

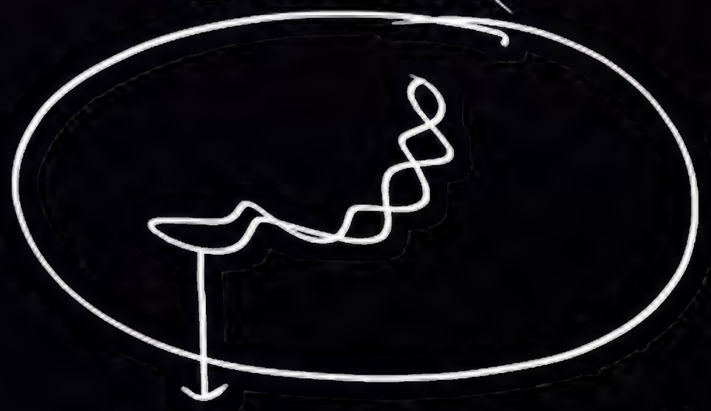
(a) one Gene

(b) two Gene

(c) Genetic material

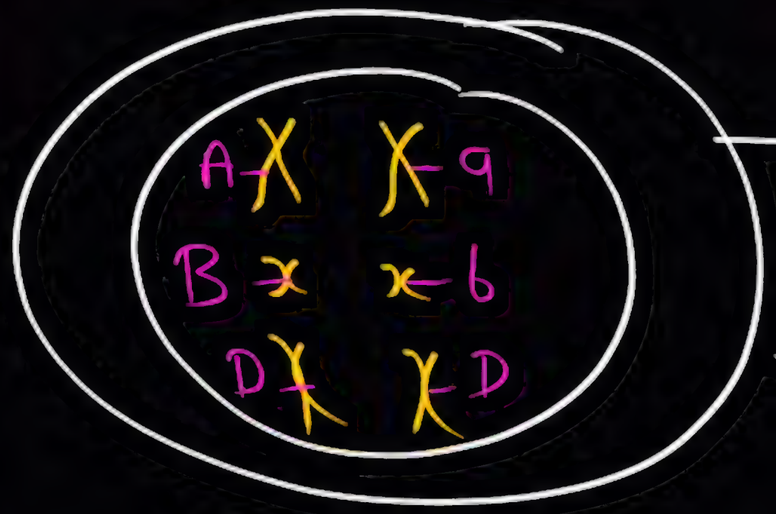
(d) none

Bacterial



1 Chromosome = nucleoid

1o Gene = genetic material = Genome



Eukaryotic cell

↓

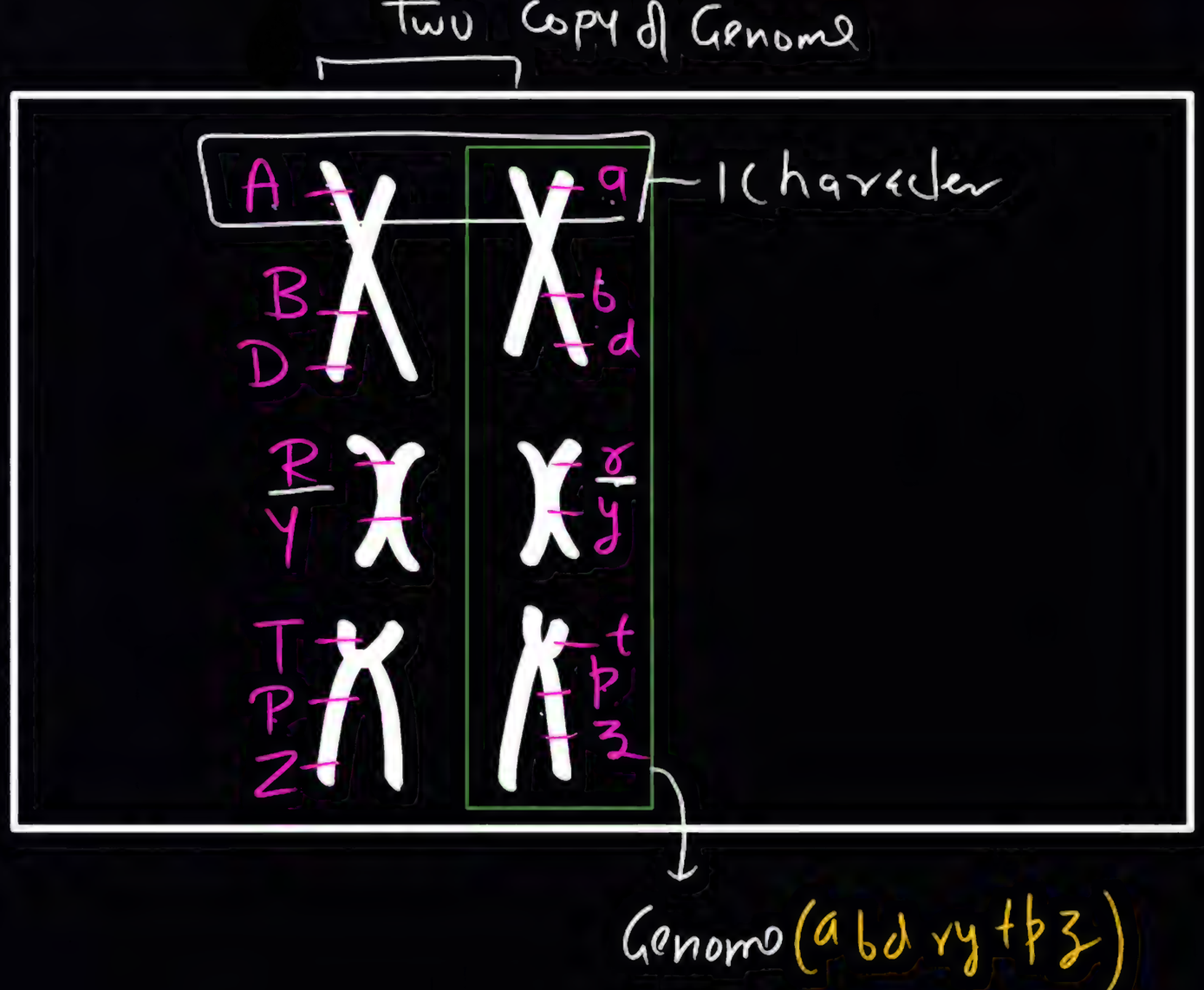
Two copy of genome

Genetic material → A, B, D, d, b, D

all genes

Genome → ABD — Haploid set

Diploid cell → Two copies of Genome



* Genetic – all Genes material on all chromosome

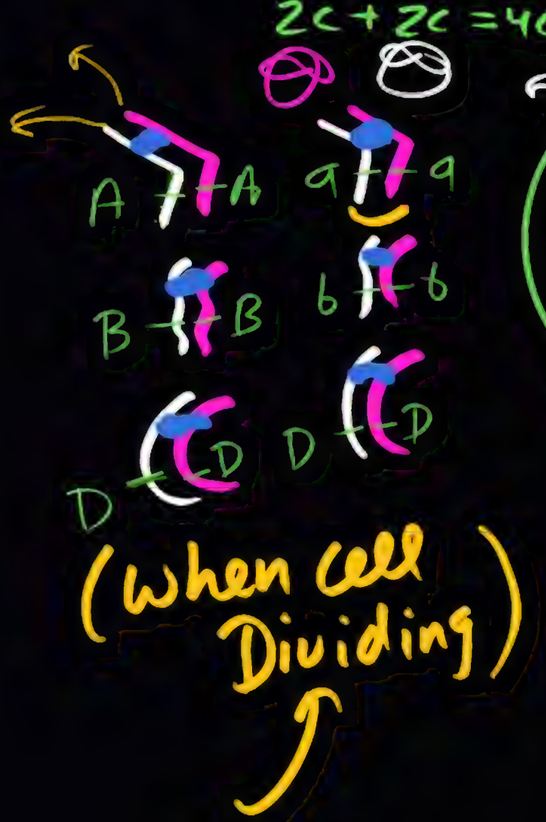
* Genome – all Genes on Haploid set of Chromosome

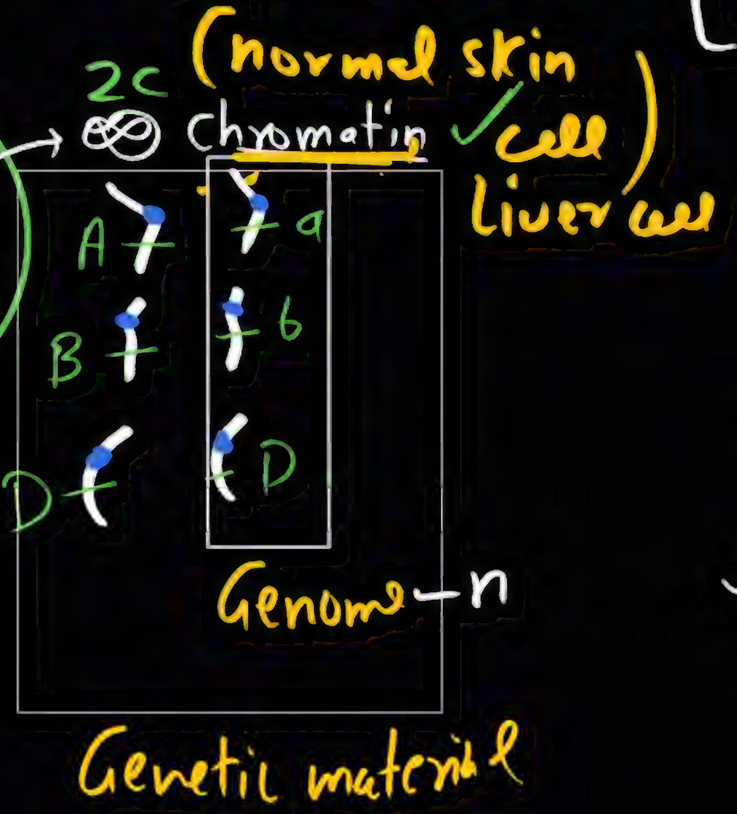
* 1 chromosome – more than one Gene

* Genotype → Aa → Monohybrid
  (AaBb → Dihybrid
  → Representation of some gene)

location of Gene

* Gene is located on DNA, so it is also present on Chromatin & chromosome
* Prokaryotes Gene present on nucleoid





Note → Virus 4 type Genetic material
(ss DNA , ss RNA
ds RNA , ds DNA)

Q Gene is located on
RNA
(a) Few cell
(b) Archaebacteria
(c) all Virus
(d) some Virus

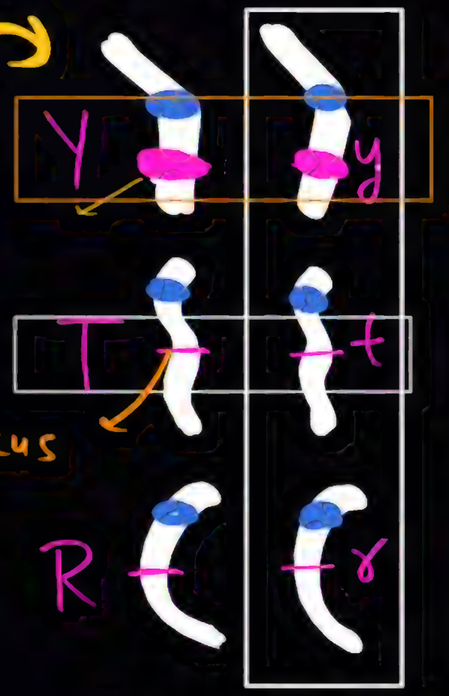
G_1 phase →

1 character = 1 locus

(Seed colour

Yellow Green

Y y



1 locus → For one character

Hapoid — out of one pair, one single Chromosome consider

⇒ y ⟶ haploid — one character

yt → haploid → two character - Different (two locus) (two gene)

y t R → haploid → three Character = three locus (three)

Diploid →

Yy → 1 character (1 locus) = 2 gene

YyTt → 2 character = 4 gene = Diploid (2 locus)

YyTtRr → 3 character = 6 gene - Diploid (3 locus)

Haploid Diploid Triploid | Monohybrid, Dihybrid

Y + y — character = Seed colour

R + r — Characked = Seed shape

T + t — Character — Plant height

1 character consider — Monohybrid → Y or y = Haploid

→ Yy, YY — Diploid

2 Character — Dihybrid → YR → Haploid

YYRr, Yyrr — Diploid

3 Character — Trihybrid → Haploid → TRY, Try

→ Diploid → TtRrYy

One character → Monohybrid

Haploid — T

Diploid → Tt, tt, TT

Triploid → TTT, Ttt, ttt

Two character — Dihybrid

Haploid → TR

Diploid → TtRr, TTRR

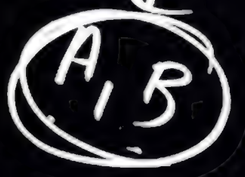
Triploid → TTt RRr

Ttt or rrr

Character	Ploidy
TTRr → 2	2n
TRY → 3	n
TTTRRR → 2	3n
TTTRRRYYY → 3	3n

A = Ab

A Dihybrid plant Can Form Gamete → n → n



(a) A ✗

(b) Ab

(c) AA ✗

(d) BB ✗

DOPA -01

Q1 In a Dihybrid which is true
(a) one locus involve (b) two locus involve (c) two character (d) both b & c

Q2 Which have most gene in skin cell
(a) chromosome (b) Genome (c) Genetic material (d) X-chromosome

Q3 SS DNA have gene in
(a) Prions (b) all virus (c) Viroids (d) Some virus

Q4 Which is Common in Mycoplasma & Yeast cell
(a) have ds DNA (b) RNA as Genetic material (c) have Gene on DNA (d) Both 1 & 3

Q5 TtRr involve
(a) two locus (b) one character (c) Gamete (d) Haploid

Q6 Which is possible Genotype of sperm
(a) Aa (b) AaBb (c) AAA (d) all

Q7 Trihybrid haploid is all Except
(a) AAA (b) bbb (c) Aab (d) Yyy

Q8 Dihybrid Diploid is
(a) Both character Homozygous (b) Both locus Heterozygous (c) Both locus Heterozygous (d) all

Q9 Endosperm genotype can be
(a) TtRr (b) TTT (c) Ttt (d) TtRrYy

Q10 Bacteria have Gene on
(a) Nucleoid (b) Plasmid (c) Organelle (d) Both a&b

How chromatin and chromosome vary

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principle of inheritance

lecture-02

Botany

TARUN SIR

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Mendelian principle- hybridisation experiment,result,law and cross

Gene interaction- incomplete dominance,co-dominance and muliple allele, polygenic inhritance

DOPA Prime-1

Chromosomal theory, linkage and sex determination

Dopa prime -2

Mutation,pedigree analysis , genetic disroder

Dopa prime -3

DOPA -01

AaBb, AABB

Q1 In a Dihybrid which is true

(a) one locus involve (b) two locus involve (c) two character (d) both b & c

Q2 Which have most gene in skin cell

(a) Chromosome (b) Genome (c) Genetic material (d) X-chromosome

Q3 SS DNA have gene in

(a) Prions (b) all virus (c) viroids (d) some virus

Q4 Which is common in Mycoplasma & Yeast cell

(a) have ds DNA (b) RNA as Genetic material (c) have Gene on DNA (d) Both 1 & 3

Q5 $\overline{T}$ & $\overline{R}$ involve (2n)

(a) two locus (b) one character (c) Gamete (n) (d) Haploid

Q6 Which is possible Genotype of sperm — n

(a) Aa (b) AaBb (c) AAA (d) AB — n

Q7 Trihybrid haploid is all Except - - -

(a) AAA (b) bbb (c) Aab (d) ABD

Q8 Dihybrid Diploid is

(a) Both character Homozygous (b) Both locus Heterozygous (c) One locus Heterozygous (d) all

Q9 Endosperm genotype can be (3n)

(a) TtRr (b) TTT (c) Ttt (d) TtRrYy

Q10 Bacteria have Gene on

(a) Nucleoid (b) Plasmid (c) Organelle (d) Both a & b

n

A | AB | ABC

AaBb AABB AaBB

2n

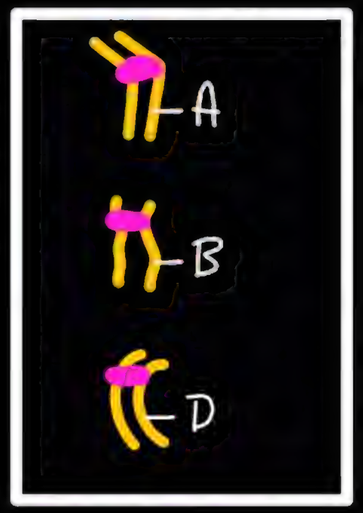
Aa | AaBb | AaBbCc

3n

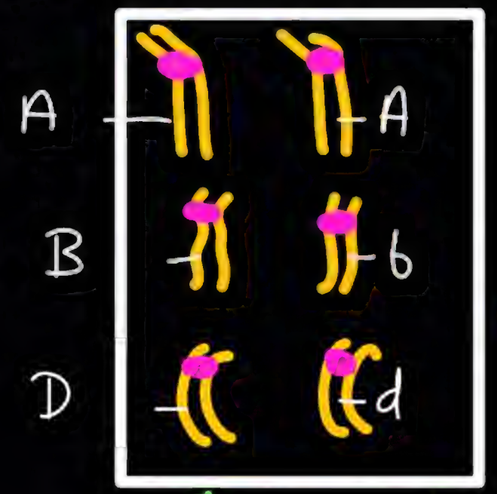
AAA Aa | AAABBB

T T t t

Haploid and Diploid



Haploid



Diploid

Haploid means

(a) Odd no. of chromosome (24 → 48, n → 2n)

(b) Even no. of chromosome

(c) one set of chromosome Each of Different type

(d) all

Q2 Identify Haploid

(a) TR

(b) TT — 2n

(c) TTRR — 2n

(d) Tt — 2n

Q3 Identify Diploid

(a) TR — n

(b) TRY — n

(c) RY — 2n

(d) RRR — 3n

Q4 Identify triploid

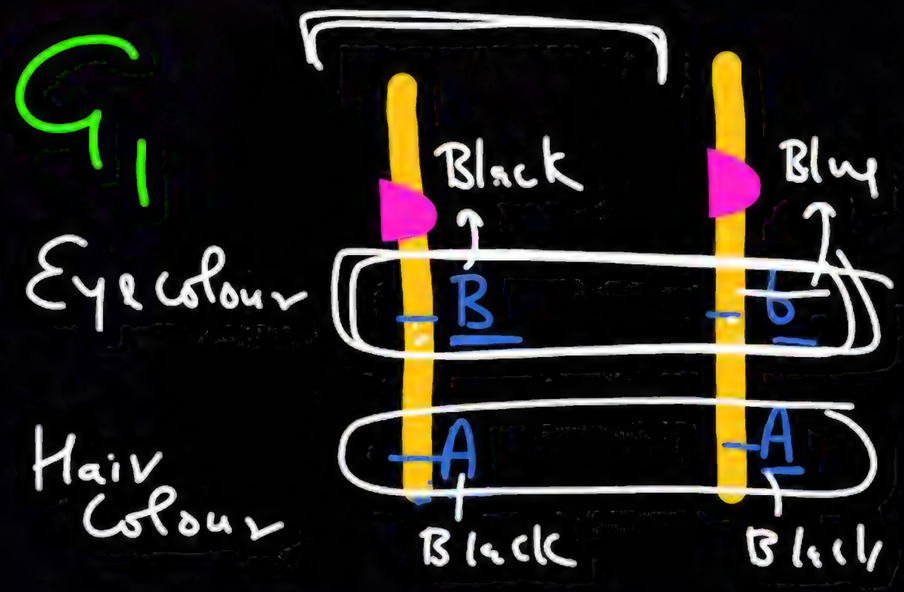
(a) TRY — n

(b) TTRRYY 2n

(c) TTT — 3n

(d) TR — n

Homozygous & Heterozygous & locus



Bb – Heterozygous

AA – Homozygous

Q In Homologus chromosome pair if A & a present on two chomosome then it is

(a) Homozygous

(b) Heterozygous

A 7 7 a

Q One locus means gene of

n → A B C D

2n → Aa Bb Cc Dd

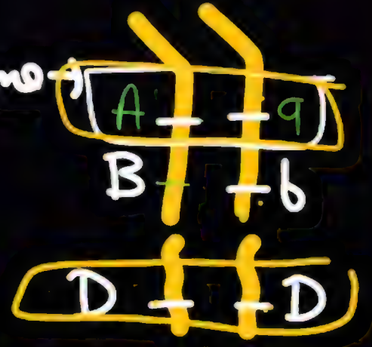
(a) Same Character ✓

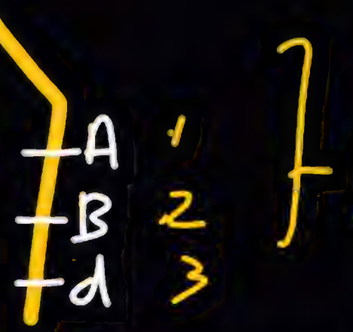
(b) T & R present X

(c) T & t can present ✓

(d) Both a & c

Q Given Diagram of





locus → (a) one (b) two (c) three

Q total Gene → (a) one (b) two (c) three

Q (a) Haploid
(b) Diploid

Q1 No. of locus
(a) one (b) two (c) three (d) Four

Q2 No. of character
(a) one (b) three (c) two (d) Four

Q3 Homozygous locus
(a) one (b) two

Q4 AaBb DD → Represent all Except A
(a) three character (b) Six gene (c) Diploid
X (d) Homozygous Each locus

Genotype — Genetic make up / Genes (Aa, AaBb, TT, t — haploid Genotype)

Diploid Genotype

Phenotype → External Appearance (Ex - tall, Round, Black(-eye))

Homozygous → When one locus two gene → Both Gene similar TT, tt

(For Homozygous → organism Should be Diploid)

A A

heterozygous → when one locus → two gene → Both Gene Disimilar

Tt, Rr

T t

Zygote is Diploid observe

Hemizygous — half → haploid → T → gamete - hemizygous

TR → Hemizygous

TRY → Hemizygous

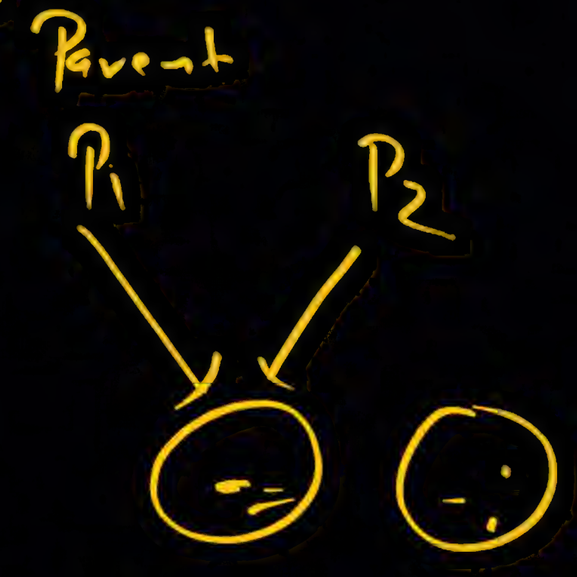
Q Genetics involve

(a) Sexual Reproduction progeny ✓

(b) Asexual Reproduction progeny

(c) Both

(d) none



Q Variation is

(a) Amount of Difference in two parent ✗

(b) Difference in parent & progeny ✓

(c) Progeny of same parents ✓

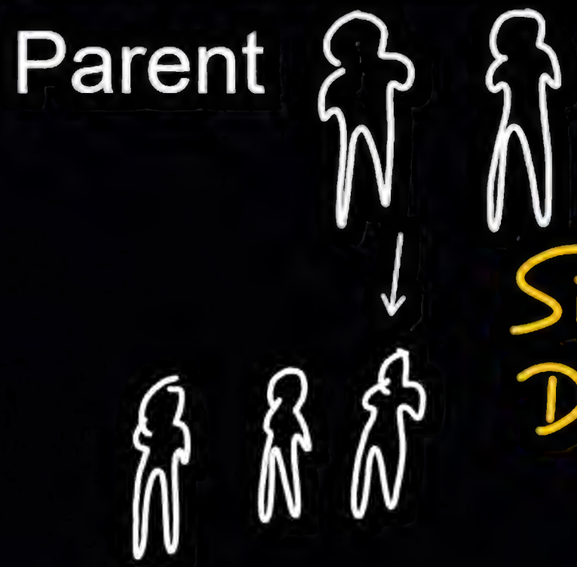
(d) Both b & c ✓

Have you ever wondered why an elephant always gives birth only to a baby elephant and not some other animal? Or why a mango seed forms only a mango plant and not any other plant?

Elephant → Elephant

Mango → Mango

Given that they do, are the offspring identical to their parents? Or do they show differences in some of their characteristics? Have you ever wondered why siblings sometimes look so similar to each other? Or sometimes even so different?

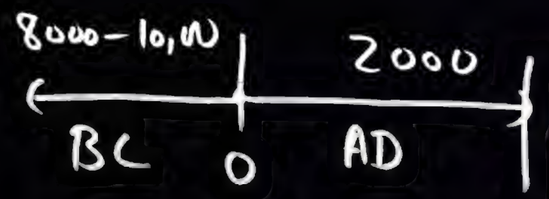


Similarity
Different

Genetics →

These and several related questions are dealt with, scientifically, in a branch of biology known as Genetics. This subject deals with the inheritance, as well as the variation of characters from parents to offspring. Inheritance is the process by which characters are passed on from parent to progeny; it is the basis of heredity. Variation is the degree by which progeny differ from their parents.

Knowledge of genetics



→ 8000-10,000 year old - Agriculture

→ Agriculture ⟶ Use variation of Animals & Plants - in wild varieties

→ Source of variation → Sexual Reproduction (little knowledge of Genetics)

Artificial hybridization & Domestication ➡ Present day Crops Evolve

Ex - Sahiwal Cow - Punjab

Genetics → Pre mendial concepts ⟶ Mixing of trait occur From parent (Blending inheritance)

Genetics → Mendian Concept ⟶

Genetics ↘ Linkage, chromosomal theory

wild cows, we have well-known Indian breeds, e.g., Sahiwal cows in Punjab. We must, however, recognise that though our ancestors knew about the inheritance of characters and variation, they had very little idea about the scientific basis of these phenomena.

Father of Genetics

→ Sisilian village – Austria – Birth place
→ Joined Monastery ⟶ Sent to university of vienna ⟶ Return & Joined Monastery → as a substitute

Experiment – Pea plant – Pisum sativum (Bisexual Flower)

- Year ⟶ 7 year → 1856 – 63 [Hybridization Experiments]
  Work published → 1865 (Unrecognised)

1900 → Carl correns
Erich von Tschemak
Hugo de Vries
} Rediscover Mendel's work

Hybridization Experiments (Plant Breeding Experiment)

Steps → (1) Selection of Parent → in which cross perform

(2) Cross B/w Parent

(3) Observation & Result

(4) Inference → (later develop into law)

Why Mendel work was Different

For cross large sample size — Greater credibility to Result

① large sample size →

② Use mathematical logic → Use Statistical Analysis & Mathematical logic

③ Give General principle → Try to Explain General principle

Rather not try to Explain or Give Unsubstainted data

④ Results – Multiple time check

↳ Repeated Selfing → F_1 F_2 F_3 } For many Generation

Tall X Dwarf

↓

Tall

↓

3 Tall : 1 Dwarf

2990 : 1015

I Selection of parents (First step of Hybridization)

→ Mendel in Pea plant → 14 true breeding variety | Pure line variety select

Differ only in one trait

total → 7 character | 14 varities (14 trait)

True Breeding | Pure = Homozygous

Tall (Pure)
↓ selfing
Tall
↓ selfing
Tall

Character	Dominant trait	Recessive trait	
1. Plant height	Tall	Dwarf	4
2. Flower colour →	Violet	White	1
3. Flower Position →	Axial	Terminal	4
4. Pod shape →	Smooth (Inflated)	Constricted	4
5. Pod colour →	Green	Yellow	5
6. seed shape →	Round	Wrinkled	7
7. seed colour →	Yellow	Green	1

Pea plant → 7 pair (chromosome)
↓
7 characters mendel
Select → 4 chromosome
(4, 1, 5, 7)

Plant height → F → P — S
colour → cl

Q Which is true Breeding
(a) Aa (b) TT (c) Bb
(d) Rr

* Mendel selected those character → two trait (Contrasting → one Dominant one Recessive)

* Some character → Eye colour → More than two trait
(Black, Blue, Brown)

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SANKALP NEET VEDANTU

principle of inheritance

lecture-03

Botany

TARUN SIR

Topics

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Gene interaction- incomplete dominance,co-dominance and muliple allele, polygenic inhritance

DOPA Prime-1

Chromosomal theory, linkage and sex determination

Dopa prime -2

Mutation,pedigree analysis , genetic disroder

Dopa prime -3

4.1 Mendel's Laws of Inheritance

It was during the mid-nineteenth century that headway was made in the understanding of inheritance. Gregor Mendel, conducted hybridisation experiments on garden peas for seven years (1856-1863) and proposed the laws of inheritance in living organisms. During

Hybridization Experiment

Steps - ① Parent selection ✓

② Cross ✓

③ Observation ✓

④ Inference ✓

Hybridization Experiments

Selection of parent ⟶ 14 Pure line | true Breeding

7 character ⟶ 14 traits

Pair of Plants – Differ only in one trait

	Dominant	Recessive	
Plant height	Tall	Short	4
Flower colour	Violet	white	1
Position	Axial	terminal	4
Pod shape	Smooth	constricted	4
Pod Colour	Green	Yellow	5
Seed shape	Round	Wrinkled	7
seed Colour	Yellow	Green	1

P
F ⟶ colour

P ⟶ colour

S ⟶ colour

Table 4.1: Contrasting Traits Studied by Mendel in Pea

S.No.	Characters	Contrasting Traits
1.	Stem height	Tall/dwarf
2.	Flower colour	Violet/white
3.	Flower position	Axial/terminal
4.	Pod shape	Inflated/constricted
5.	Pod colour	Green/yellow
6.	Seed shape	Round/wrinkled
7.	Seed colour	Yellow/green

D R D R

Q1 From Following → tall plant, termined Flower, Green pod, Wrinkled seed, White Flower

How Many are Dominant trait

(a) two (b) three (c) Four (d) Five

Q2 Acc. to Mendel, one character have

(a) More than two trait

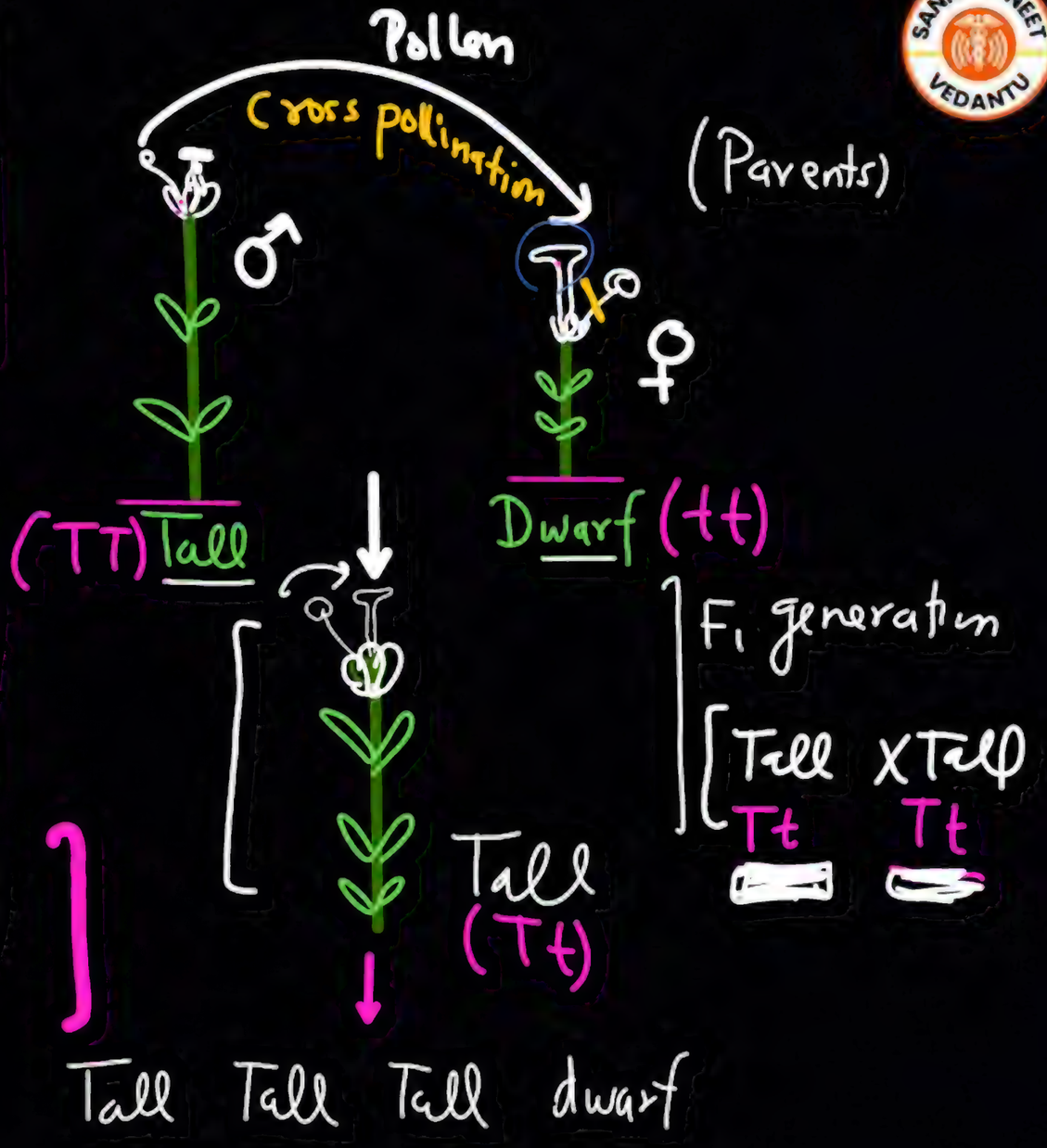
(b) one contrasting trait

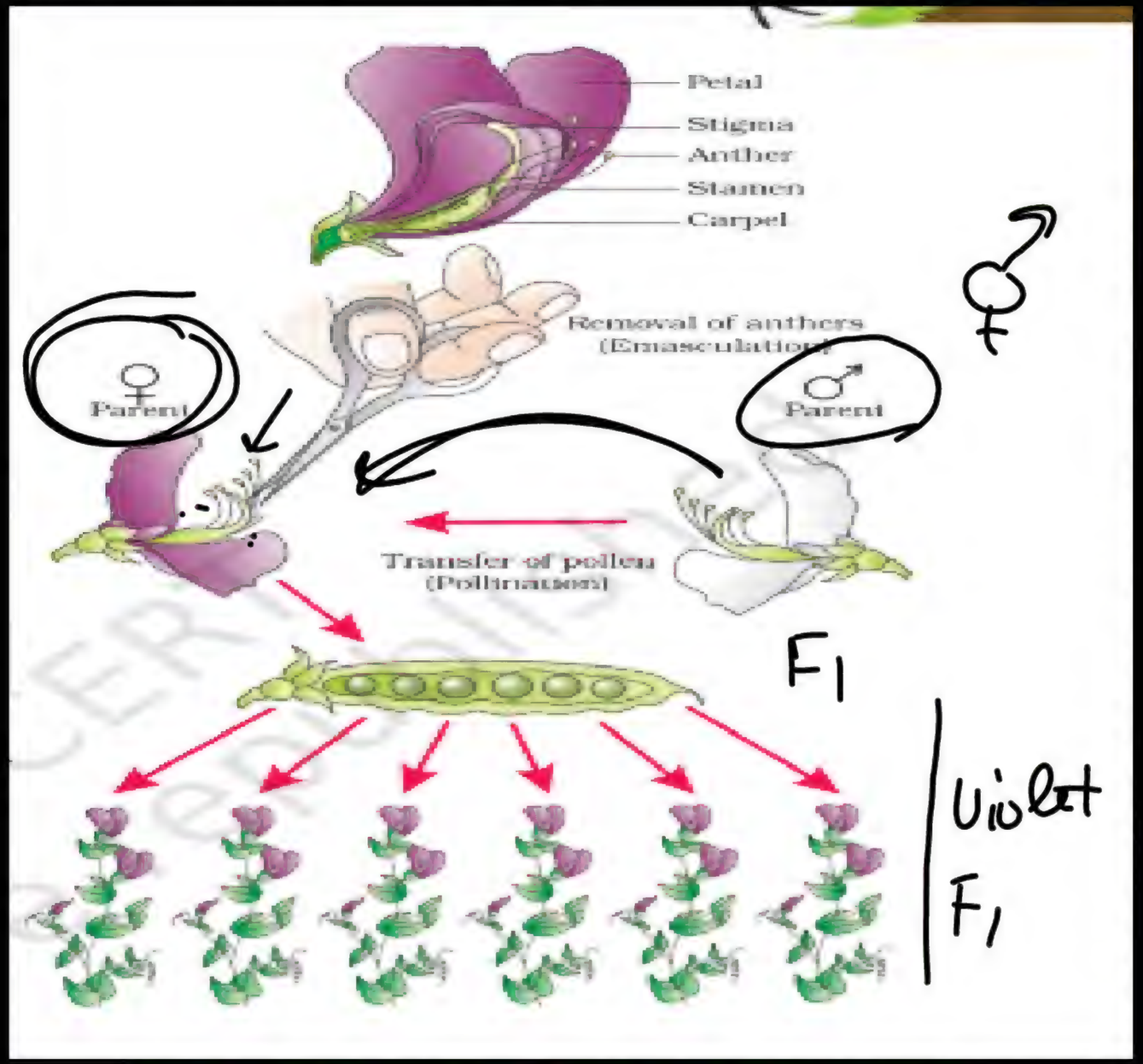
(c) two contrasting traits

(d) all

Cross Between selected parents

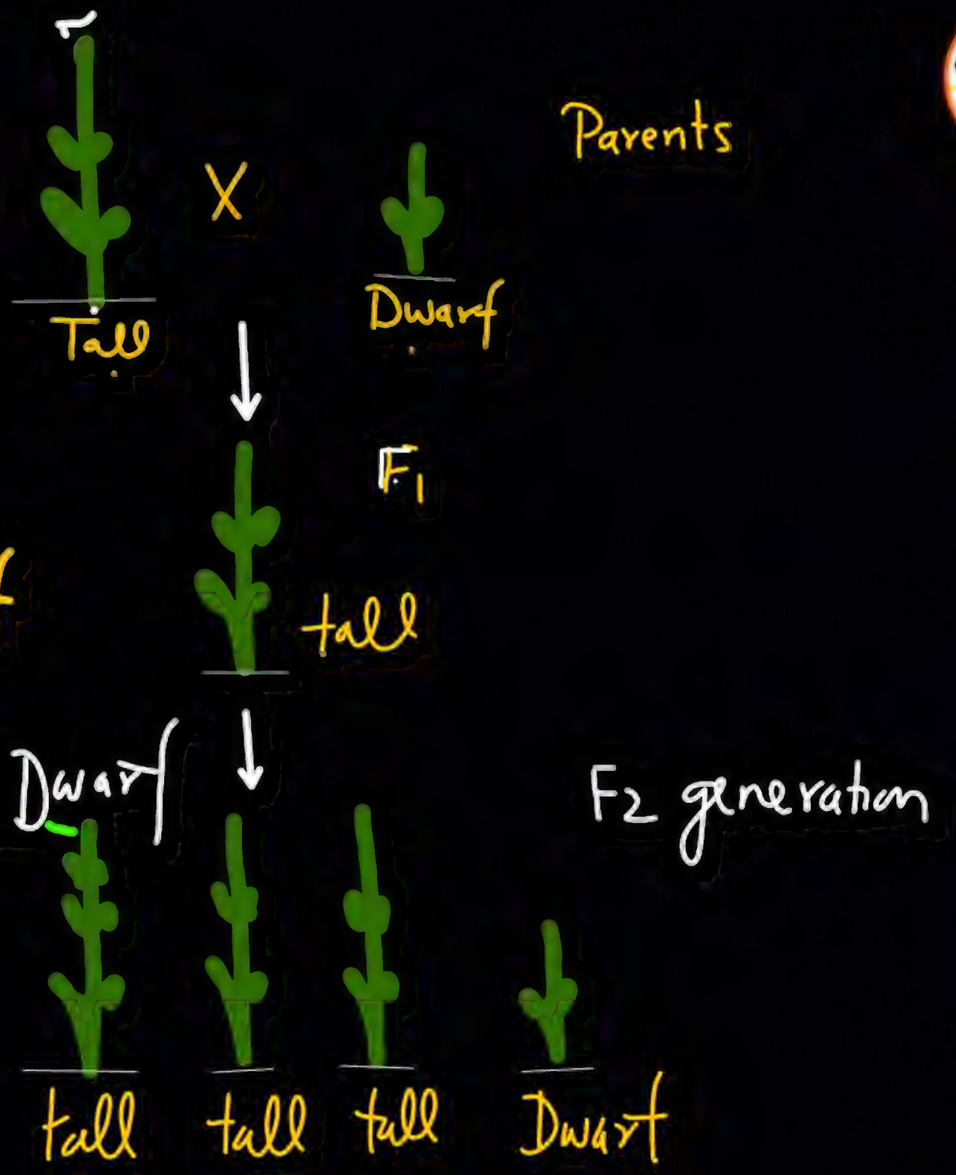
- Pea plant – Bisexual Flower
  (Flower → use Female Flower → Bagging Emasculation
- → Two pure parents → crossed & F_1 Hybrid / Filial I generation
- → Plant of F_1 generation selfing is done (Autogamy, Geitonogamy)
- → Plant of F_2 generation (Both tall, Dwarf)




Petal
Stigma
Anther
Stamen
Carpel
Removal of anthers
(Emasculation)
Parent
Parent
Transfer of pollen
(Pollination)
F1
Violet
F1

Result of cross

- F_1 generation → only tall plant
  - → Resemble any one of the parent Completely
- Selfing of F_1 → F_2 generation, progeny of Both type — tall, dwarf
  - F_2 generation → tall more in number than Dwarf
  - → tall and dwarf → 3 : 1 Ratio



4.2 Inheritance of One Gene

Let us take the example of one such hybridisation experiment carried out by Mendel where he crossed tall and dwarf pea plants to study the inheritance of one gene (Figure 4.2). He collected the seeds produced as a result of this cross and grew them to generate plants of the first hybrid generation. This generation is also called the **Filial$_1$ progeny** or the **F$_1$**. Mendel observed that all the F$_1$ progeny plants were tall, like one of

This generation is also called the **Filial$_1$ progeny** or the **F$_1$**. Mendel observed that all the F$_1$ progeny plants were tall like one of its parents; none were dwarf (Figure 4.3). He made similar observations for the other pairs of traits – he found that the F$_1$ always resembled either one of the parents, and that the trait of the other parent was not seen in them.

Mendel then self-pollinated the tall F$_1$ plants and to his surprise found that in the Filial$_2$ generation some of the offspring were 'dwarf'; the character that was not seen in the F$_1$ generation was now expressed. The proportion of plants that were dwarf were 1/4th of the F$_2$ plants while 3/4th of the F$_2$ plants were tall. The tall and dwarf traits were identical to their parental type and did not show any blending, that is all the offspring were either tall or dwarf, none were of in-between height (Figure 4.3).

Figure 4.2 Steps in making

Similar results were obtained with the other traits that he studied: only one of the parental traits was expressed in the F_1 generation while at the F_2 stage both the traits were expressed in the proportion 3:1. The contrasting traits did not show any blending at either F_1 or F_2 stage.

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Tall T.T × Dwarf tt

↓

Tall (Phenotype)

Tt

↓

F_2

Q F_1 Generation in Mendelian cross

(a) Pure (b) true breeding (c) Homozygous (d) Hybrid ✓

Q F_1 Generation in Mendelian cross

(a) Genotype similar to one parent ×

(b) Phenotype similar to Both parent ×

(c) Phenotype Similar to Any one Parend

(d) Genotype similar to Both parent

Q F_2 Generation is

(a) Result of selfing of F_1

(b) Result of Autogamy & Geitonogamy

tall ♂ tall ♀

Tt TT

(c) Result of cross B/w parent of Similar Genotype

Tt × Tt

(d) all

Inference conclusion

→ Something (Factor) stably passed ⟶ From one Generation to other through gametes

[Something = Factor]
↳ Unit of inheritance
(now it known as Gene)

Tall (TT) ↓ Dwarf (tt) (Pure)

Tall (T) Selfing → Segregation → T, t gamete

Tall (TT) | Tall (Tt) | Tall (Tt) | Dwarf (tt)

Features of Mendelian Factors

(a) Stable (not change)
(b) Discrete (individual)
(c) Occur in pair (organism)
- Pair – Similar → TT, tt
- Pair – Disimilar → Tt

(d) Factors Seperate | Segregate during gamete Formation
(e) One Factor control one trait

Tall (Tt) × Tall (Tt)

T, t gametes | T, t gametes

Q Mendelian Factor is

(a) Unit of inheritance (b) occur in Pair in Individual TT, Tt, tt (c) occur in Pair in Heterozygous (Tt) ~~(d) all~~

Q Mendelian Factor is

(a) Dominant T (b) Recessive t (c) Pass through gamete ~~(d) all~~

Inference

Based on these observations, Mendel proposed that something was being stably passed down, unchanged, from parent to offspring through the gametes, over successive generations. He called these things as 'factors'. Now we call them as **genes**. Genes, therefore, are the units of inheritance. They contain the information that is required to express a particular trait in an organism. Genes which code for a pair of contrasting traits are known as **alleles**, i.e., they are slightly different forms of the same gene.

T – Factor

concept of Allele

- Factor- unit of inheritance

T = Factor (mendel) also gene

t → Factor or gene

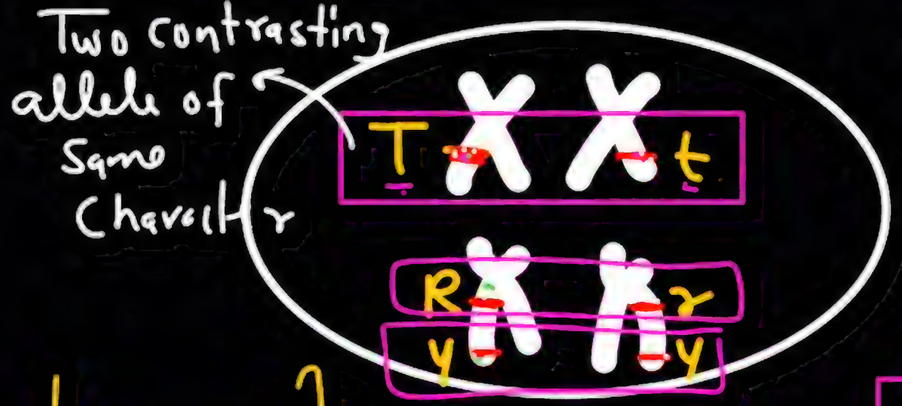
T & t → Two gene locus common [character common]

T & t → two allele of one locus

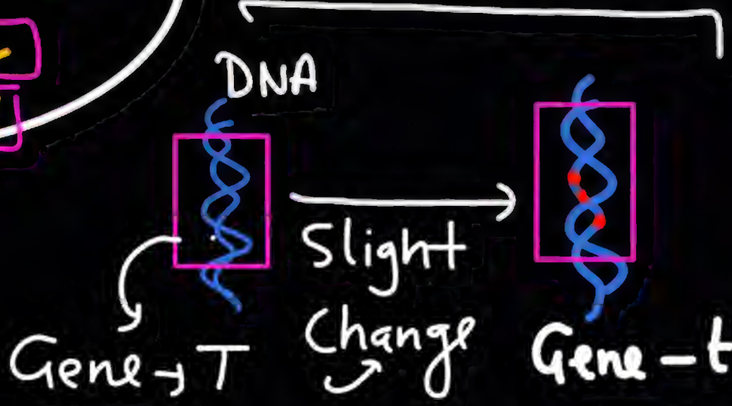
Eye colour (character) → 4 allele

Black eye, Blue, Brown, Green eye

4 Gene and 4 allele



Slight modification of T give t gene



Alleles → T & t (two gene & two allele)

Alleles are those genes which code For contrasting trait

Q T & t are two

(a) Gene (b) Allele (c) Alleles of one character (d) all

Q T & R are two

(a) Gene (b) allele (c) Alleles of two Different character (d) all

Q T & T are two

(a) Similar gene (b) Similar allele (c) Same locus (d) all

Q Y & R have

(a) Different locus (b) two gene of one locus (c) Same locus allele (d) all

Gene Symbol

Plant height - Tall - T - Dominant
Dwarf t - Recessive

I Character with two contrasting trait ⟶

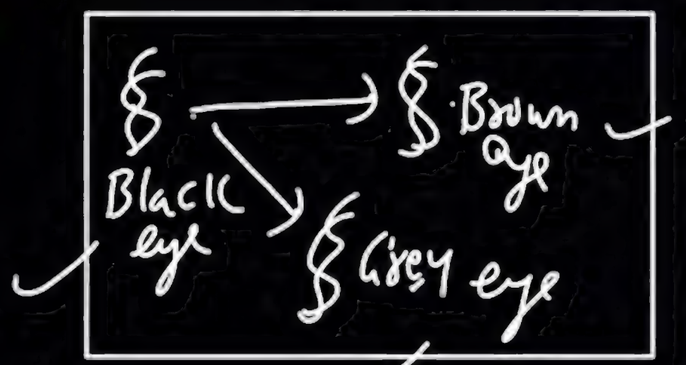
m - miniature wing → Recessive
m^+ - normal wind - Dominant

Drosophila → white eye - Recessive → w
Red eye - Dominant → w^+ (wild type)
yellow Body - Recessive → y
Brown Body → → y^+

II One character → more than two allele — Eye colour (Black eye, Blue, Brown, Grey, Red eye)

I^{Blk} I^{Bly} I^{Brw} I^{Gr} I^{Red}

Blood Group (Character) → I^A, I^B, i — 3 Gene / 3 allele



How Gamete Form

TT → T, T

Type → only T

Tt → T, t — Two type

TtRy → TR, Ty, tR, ty — Four type

TtRy → 2000 pollen → ? pollen → T → 1000

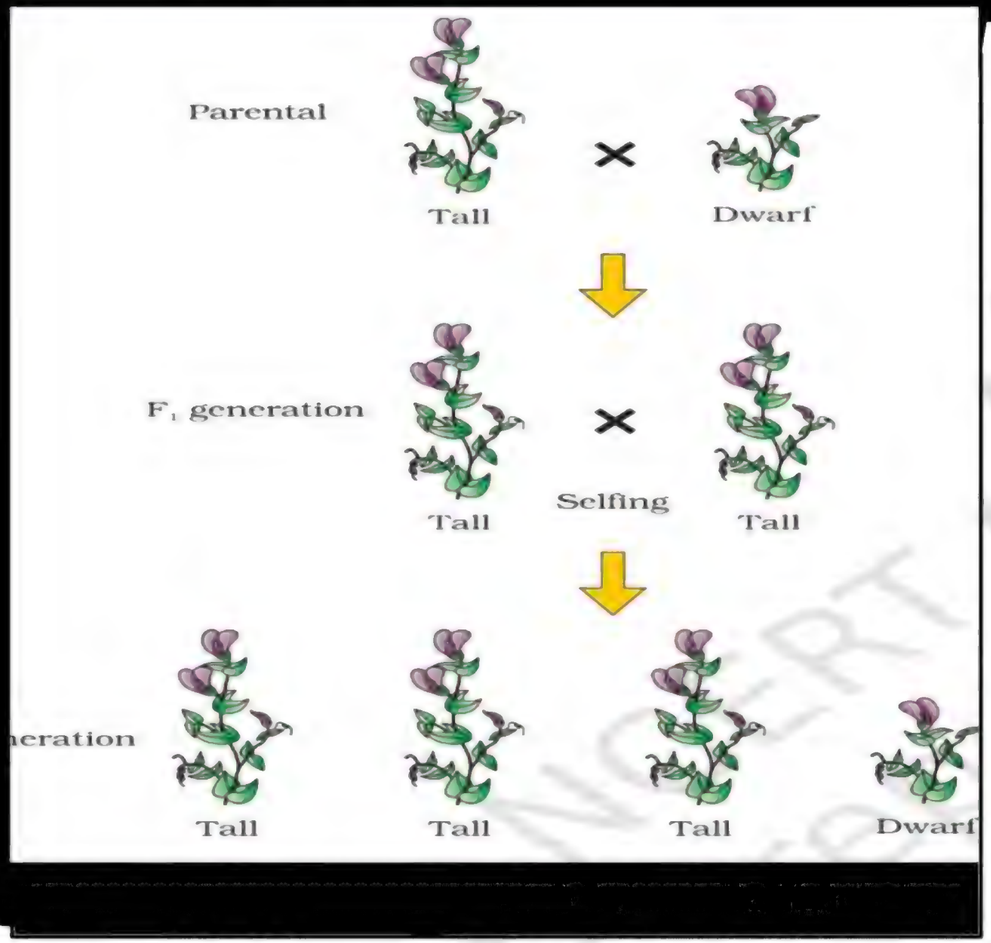
what is segregation

Tt → T, t

(a) occur for two allele of Different Character

TtRy → TR, Ty, tR, ty

~~(b)~~ occur for two allele of same



If we use alphabetical symbols for each gene, then the capital letter is used for the trait expressed at the F_1 stage and the small alphabet for the other trait. For example, in case of the character of height, **T** is used for the Tall trait and **t** for the 'dwarf', and **T** and **t** are alleles of each other. Hence, in plants the pair of alleles for height would be **TT**, **Tt** or **tt**. Mendel also proposed that in a true breeding, tall or dwarf pea variety the allelic pair of genes for height are identical or **homozygous**, **TT** and **tt**, respectively. **TT** and **tt** are called the **genotype** of the plant while the descriptive terms **tall** and **dwarf** are the **phenotype**. What then would be the phenotype of a plant that had a genotype **Tt**?

Type of Mendelian cross

I Monohybrid cross

II Dihybrid cross

III Testcross

Back cross

Reciprocal cross

Monohybrid cross → One character Consider → Ex- Plant Height

Parents (Pure)

Tall TT × Dwarf tt

all F_1 generation tall Tt

↓ selfing

F_2 generation

Tall TT, Tall Tt, Tall Tt, Dwarf tt

* F_1 Generation — Phenotype = tall, Genotype = Tt

* F_2 Generation → Phenotype = 2, tall = 3/4, Dwarf = 1/4

Phenotypic Ratio 3:1

F_2 Generation

Genotype = 3

TT = 1/4

Tt = 2/4

tt = 1/4

Genotypic Ratio:- 1:2:1

Parents

Tall TT × Dwarf tt

F_1

Tall Tt × Tall Tt

F_2

male gamete / Female gamete	T	t
T	TT	Tt
t	Tt	tt

→ Punett square (British — R.C Punett)

- It is Graphical Representation to show possible genotype

- In two side of punett squar gametes Represent

TtR_2 X TTR_2 = 8 Box

4 2

TR

tr

Tr

tR

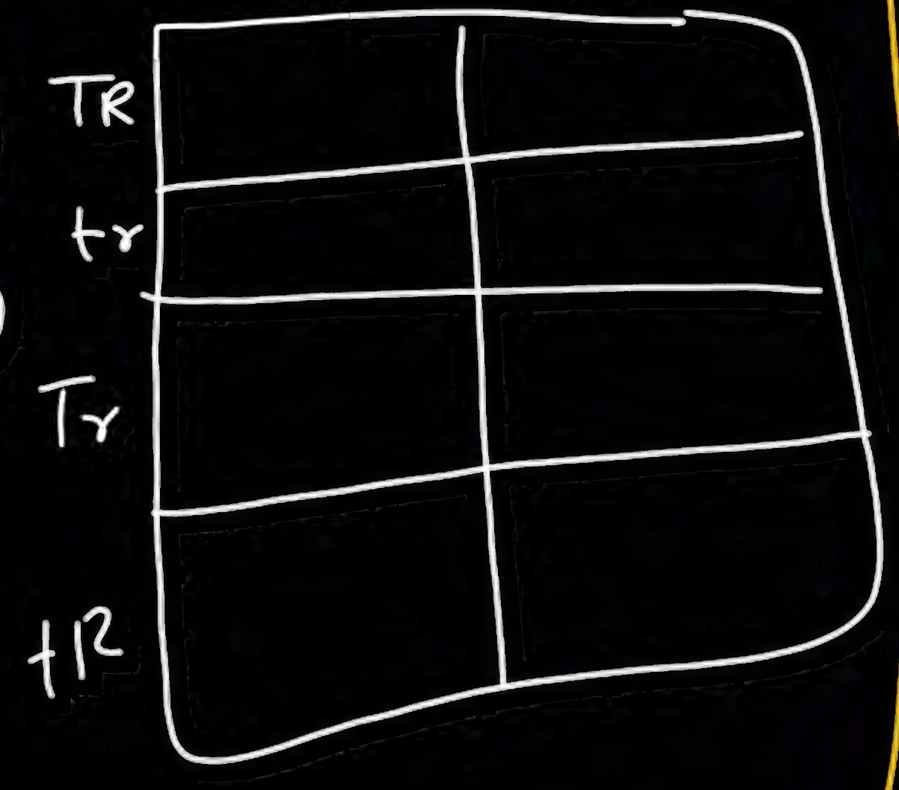
TR

tr

~~Tr~~

Tr

tR



TtR_2 X TtR_2

↓ ↓

4 4

DOPA - 02

Q1 Tt is (a) Phenotype (b) Genotype (c) Both (d) none

Q2 tall and Dwarf in F_2 generation
(a) Both Pure (b) Both not pure (c) Recessive is pure (d) all

Q3 F_1 generation in Mendelian cross
(a) Similar to Both parent (b) Not similar to any parent (c) intermediate of Both (d) none

Q4 Punett square is Graphical Representation of Possible
(a) Progeny (b) Phenotype (c) Genotype (d) Both a & c

Q5 In F_1 generation of Cross B/w pea plant violet (Pure) & white Flower (pure
(a) all violet (b) 50% violet & 50% white (c) all pure white (d) all white

Q6 Two allele of one character which is contrasting
(a) T & T (b) T & R (c) T & t (d) all

Q7 Which not true About Mendel Factor
(a) occur in pair (b) Segregate during gamete Formation (c) one character many Factor (d) Factors pair Can be contrasting

Q8 Which is true About allele
(a) it control trait (b) One gene two allele (c) one allele two gene (d) all

Q9 TtRr Form gametes
(a) TT, Tt, TR (b) TR, Tr (c) TR, Rr, Tt, Tr (d) all

Q10 Number of phenotype in Mendelian cross in F1 generation (Monohybrid)
(a) two (b) three (c) one (d) all

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principle of inheritance

lecture-04

Botany

TARUN SIR

Topics

introduction-gene,allele ,chromosome ,haploid,diploid

Mendelian principle- hybridisation experiment,result,law and cross

Gene interaction- incomplete dominance,co-dominance and muliple allele, polygenic inhritance

DOPA prime-1

Chromosomal theory, linkage and sex determination

Dopa prime-2

Mutation,pedigree analysis , genetic disroder

Dopa prime-3

Type of Mendelian cross

I Monohybrid cross

II Dihybrid cross

III Testcross

Back cross

Reciprocal cross

Monohybrid cross → One character Consider → Ex- Plant Height

Parents (Pure)

Tall TT × Dwarf tt

all F_1 generation tall Tt

↓ selfing

F_2 generation

Tall TT, Tall Tt, Tall Tt, Dwarf tt

* F_1 Generation — Phenotype = tall, Genotype = Tt

* F_2 Generation → Phenotype = 2
  tall = 3/4
  Dwarf = 1/4

Phenotypic Ratio 3:1

F_2 Generation

Genotype = 3

TT = 1/4

Tt = 2/4

tt = 1/4

Genotypic Ratio:- 1:2:1

Parents

Tall TT × Dwarf tt

F_1

Tall Tt × Tall Tt

F_2

male gamete / Female gamete	T	t
T	TT	Tt
t	Tt	tt

→ Punett square (British — R.C Punett)

- It is Graphical Representation to show possible genotype

- In two side of punett squar gametes Represent

$Tt R_2$ X $TT R_2$ = 8 Box

4 2

TR

tr

Tr

tR

TR Tr

TR

tr

Tr

tR

$Tt R_2$ X $Tt R_2$

4 4

Dihybrid cross

TtRr

→ Tall Round

no. of character/locus considered → two

Parents Genotype — Tall Round X Dwarf wrinkled
Phenotype — TT RR — tt rr

Tall wrinkled X Dwarf Round
TT rr — tt RR

Tall Round
TTRR
(one gamete - TR)

Dwarf wrinkled
ttrr (one gamete - tr)

F1 → (Tall Round) (TR, Tr, tR, tr)

F1 Phenotype → 1 (Tall Round)

Genotype → TtRr

type of Gametes By F1 → Four (TR, Tr, tR, tr)

F2 → Phenotype = 4 (Four)

- Tall Round — 9/16
- Tall wrinkled — 3/16
- Dwarf Round — 3/16
- Dwarf wrinkled — 1/16

Phenotypic Ratio — 9:3:3:1

Genotype — 9

Genotypic Ratio → 1:2:2:4:1:2:1:2:1

TR	Tr	tR	tr
TTRR Tall Round	TTRr Tall Round	TtRR Tall Round	TtRr Tall Round
TTRr Tall Round	TTrr Tall wrinkled	TtRr Tall Round	Ttrr Tall wrinkled
TtRR Tall Round	TtRr Tall Round	ttRR Dwarf Round	ttRr Dwarf Round
TtRr Tall Round	Ttrr Tall wrinkled	ttRr Dwarf Round	ttrr Dwarf wrinkled

Dihybrid cross – Two character Tall Round × Dwarf wrinkled

TTRR × tt rr

↓

Tall Round

TtRr (Selfing → TtRr × TtRr) ⇒ 16 Boxes

(4) (4)

TR Tr tR tr

C C

T R

Tt

Tr

tR

TTRR Tall Round	TR Tall Round	TR Tall Round	TR Tall Round
TTRr Tall Round	TTrr Tall wrinkled	TtRr Tall Round	Tall wrinkled
TtRR Tall Round	TtRr Tall Round	ttRR Dwarf Round	ttRr Dwarf Round
TtRr Tall Round	Tall wrinkled	ttRr Dwarf Round	ttrr Dwarf wr

9|16 – tall Round

3|16 tall wrinkled

3|16 Dwf Round

1|16 Dwarf wrinkled

1 : 2 : 2 : 4 1 : 2 1 : 2 : 1

Genotype = 9

Tt

Direct Results of Dihybrid cross

Monohybrid I

Tall TT × Dwarf tt

F_1 → Tall (Tt)

↓ (T+ × Tt)

F_2 Phenotype = 2
- Tall = 3/4
- Dwarf = 1/4

F_2 – Genotype = 3
- TT = 1/4
- Tt = 2/4
- tt = 1/4

Monohybrid II

Round RR × wrinkled rr

Round (Rr)

Selfing ↓ Selfing

Phenotype = 2
- Yellow = 3/4
- Green = 1/4

Genotype = 3
- RR = 1/4
- Rr = 2/4
- rr = 1/4

Dihybrid (two monohybrid)

Tall Yellow × Dwarf Green

↓

F_1 → Tall Yellow (Tt Yy) × Tt Rr

↓

= 4

F_2 – Phenotype
- Tall yellow = 9/16
- Tall Green = 3/16
- Dwarf yellow = 3/16
- Dwarf Green = 1/16

Phenotypic Ration → 9 : 3 : 3 : 1

Genotype = 3 × 3 = 9

- TTRR = 1/16
- TTRr = 2/16
- TTrr = 1/16
- TtRR = 2/16
- TtRr = 4/16
- Ttrr = 2/16
- ttRR = 1/16
- ttRr = 2/16
- ttrr = 1/16

Genotypic Ratio → 1 : 2 : 1 : 2 : 4 : 2 : 1 : 2 : 1

Tall × Dwarf
TT tt
↓
F_1 → Tall (Tt)
↓ selfing
F_2 → Phenotype = 2 ×
Tall = 3/4
Dwarf = 1/4

Genotype = 3
TT = 1/4
Tt = 2/4
tt = 1/4

Round × wrinkled
RR rr
↓
Round (Rr)
↓ selfing
F_2 – Phenotype = 2
Round = 3/4
Wrinkled = 1/4

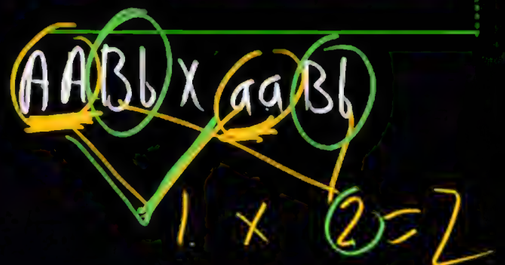
Genotype = 3
RR – 1/4
Rr = 2/4
rr = 1/4

Tall Round × Dwarf wrinkled
↓
Tall Round (TtRr)
↓
F_2 Phenotype = 4
Tall Round = $\frac{3}{4} \times \frac{3}{4} = 9/16$
Tall wrinkled = 3/16
Dwarf Round = 3/16
Dwarf wrinkled = 1/16
9 : 3 : 3 : 1

Genotype = 3 × 3 = 9
TTRR = $1/4 \times 1/4 = 1/16$
TTRr = 2/16
TTrr = 1/16
TtRR = 2/16
TtRr = 4/16
Ttrr = 2/16
ttRR = 1/16
ttRr = 2/16
ttrr = 1/16

TT × tt → 1

	Monohybrid Tall × Dwarf	Dihybrid Tall Round × Dwarf wrinkled	Trihybrid Tall Round yellow × Dwarf wrinkled Green TT RR YY × tt rr yy
F_1 phenotype →	1 (Tall)	1 (Tall Round)	Tall Round yellow
F_1 Genotype →	Tt	TtRr	TtRrYy
F_1 Form gamete →	Two (T, t) $2^1 = 2$	Four (TR, Tr, tR, tr) $2^2 = 4$ ($^nC_2 - n$ = no. of Heterozygous)	Eight → $2^3 = 8$ TRY, TRy, TrY, Try, tRY, tRy, trY, try
F_2 Box (Gamete × gamete)	2 × 2 = 4	4 × 4 = 16	8 × 8 = 64 Box
F_2 phenotype →	2 tall = 3/4 Dwarf = 1/4	4 → 9 : 3 : 3 : 1 Ratio → 9 (1:2:2:4) 1, 2, 1:2:1 3 × 3	8 → 27 genotype (3 × 3 × 3) = Three monohybrid Multiple
Genotype →	(3) (1:2:1)		



AaBbCcDdEe × AaBbCcDdEe → 2 × 2 × 2 × 2 × 2 = 32

2

Questions

(a) TT x tt ⟶ Phenotype → 1 (tall)
Genotype → 1 (Tt)

(b) TT x Tt ⟶ T T t
T → gamete
TT, Tt } 2 genotype
Phenotype = tall

(c) Tt x Tt ⟶ Phenotype = 2
Tt → 2 gamete x 2 gamete
⇒ 4 Box
Genotype = 3
TT, Tt, tt

TtRRYY x Ttrryy
3:1 → 1:2:1

IV TT Rr x tt Rr

Phe → 1 → Tall
Gen → 1 → Tt

Phe = 2
Round = 3/4
Wrinkled = 1/4

Gen → RR = 1/4
Rr = 2/4
rr = 1/4

3

Phe → 2 → Tall Round = 1 x 3/4 = 3/4
Tall wrinkled = 1 x 1/4 = 1/4

Phenotypic Ratio = 3:1

Genotypic → 1:2:1

TtRR = 1/4
TtRr = 2/4
Ttrr = 1/4

Observation:-

1. Gamete Always have one factor out of pair
2. F_1 generation Similar to phenotype of Parents
3. When we multiply two monohybrid cross
   We can get Result of Dihybrid cross

$TtRr \times TtRr$ – 16 Box

$TtRr \times ttrr \rightarrow$ 4 Box
(4 gamete) 1 gamete

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→ Test Cross

→ It is a Mendelian Cross to Find genotype of known phenotype

→ For this, Cross is made with Recessive Parent

Tall (Phenotype) (Unknown genotype) — Two possibility of Genotype

1. Tall (TT) Homozygous × Dwarf (tt) → all tall (100% tall)
2. Tall (Tt) Heterozygous × tt (Dwarf) → Tt – Tall, tt – Dwarf (50% & 50%)

T, t × t

Phenotype = 2 → tall = 1/2, Dwarf = 1/2

Phenotypic Ratio → 1:1

Genotype = 2 → Tt = 1/2, tt = 1/2

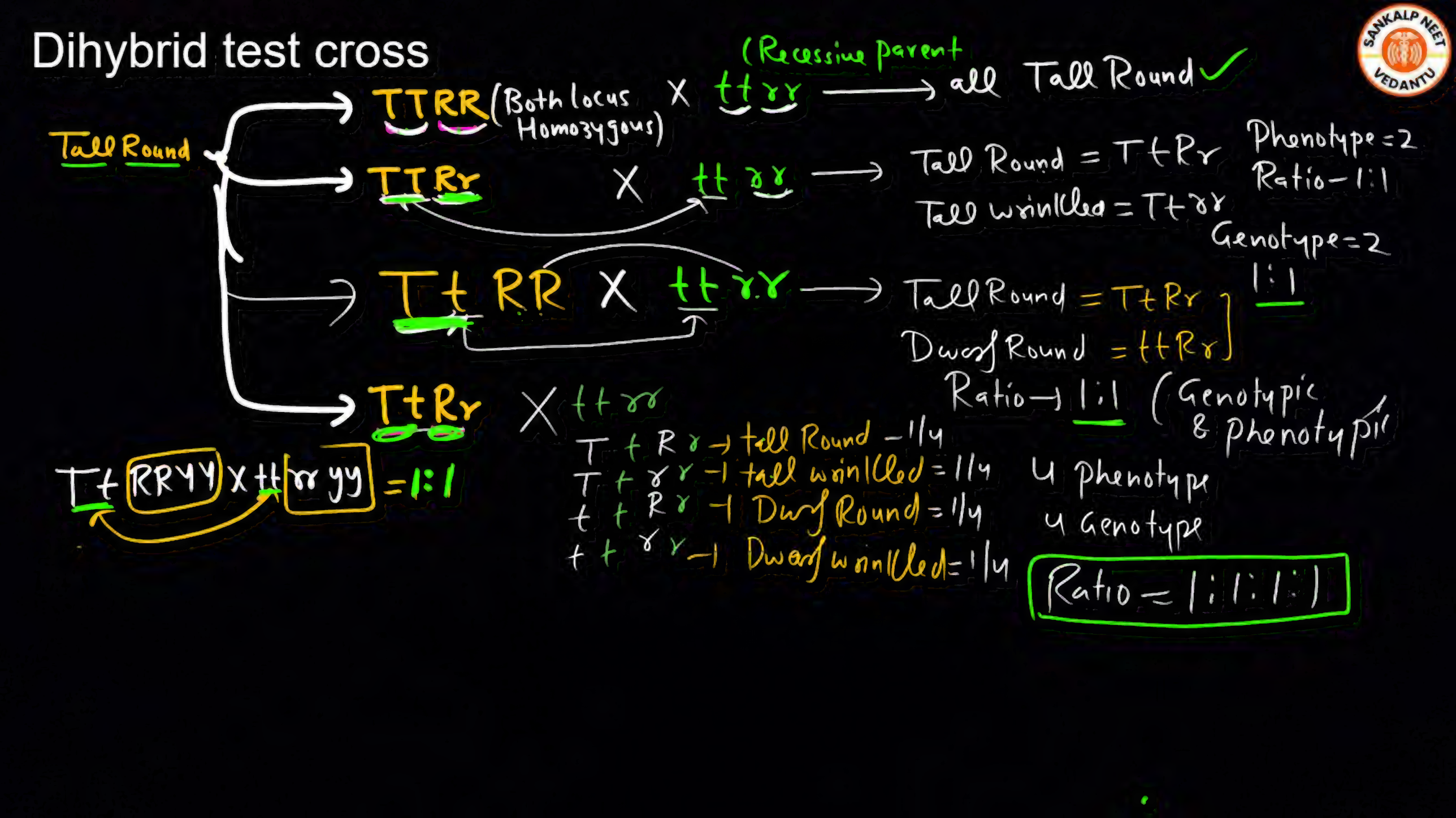
Genotypic Ratio = 1:1

note → Test Cross help to Find

(a) Genotype

(b) Number of gamete

Dihybrid test cross



Observation

(a) Tt X Tt → Phe = 2 → 3:1
Ge – 3

(b) Tt X tt → Phe – 2
Gen – 2] – Ratio – 1:1

(c) Aa BB CC DD X Aa bb cc dd

Phenotype = 2

Phenotypic Ratio = 3:1

(d) Tt RR yy X tt RR yy

Test cross → 1:1

(e) Tt Rr YY ZZ X tt rr yy ZZ

1:1:1:1

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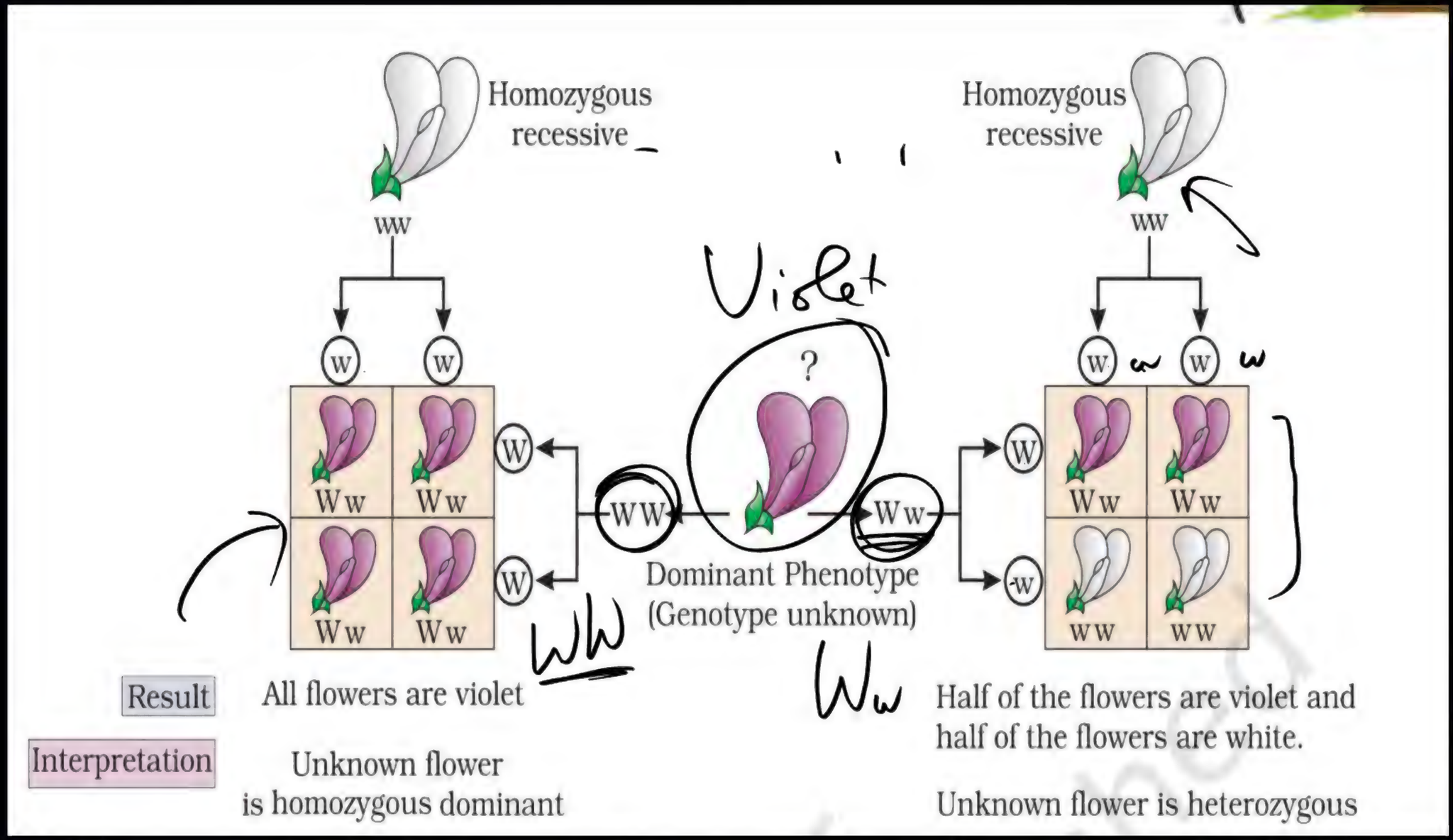
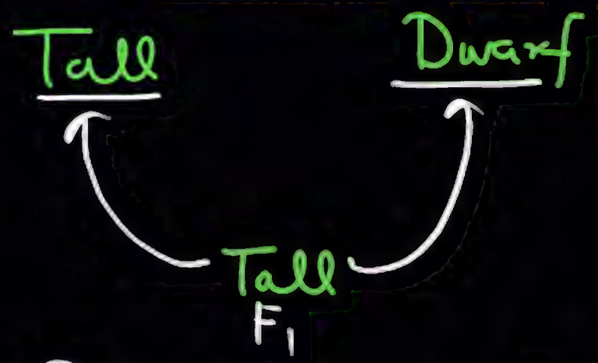

Homozygous recessive
ww
Homozygous recessive
ww
Violet
?
Dominant Phenotype
(Genotype unknown)
WW
Ww
Ww
Ww
Ww
Ww
Ww
Ww
ww
ww
Result
All flowers are violet
Half of the flowers are violet and half of the flowers are white.
Interpretation
Unknown flower is homozygous dominant
Unknown flower is heterozygous

he would have got had he self-pollinated a tall F_2 plant?

From the preceeding paragraphs it is clear that though the genotypic ratios can be calculated using mathematical probability, by simply looking at the phenotype of a dominant trait, it is not possible to know the genotypic composition. That is, for example, whether a tall plant from F_1 or F_2 has **TT** or **Tt** composition, cannot be predicted. Therefore, to determine the genotype of a tall plant at F_2 Mendel crossed the tall plant from F_2 with a dwarf plant. This he called a **test cross**. In a typical test cross an organism (pea plants here) showing a dominant phenotype (and whose genotype is to be determined) is crossed with the recessive parent instead of self-crossing. The progenies of such a cross can easily be analysed to predict the genotype of the test organism. Figure 4.5 shows the results of typical test cross where violet colour flower (W) is dominant over white colour flower (w).

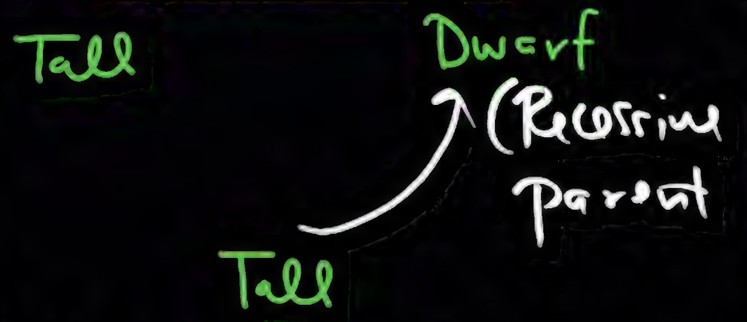
Back cross



- Progeny cross with Any of the parent

Use → Crop improvement

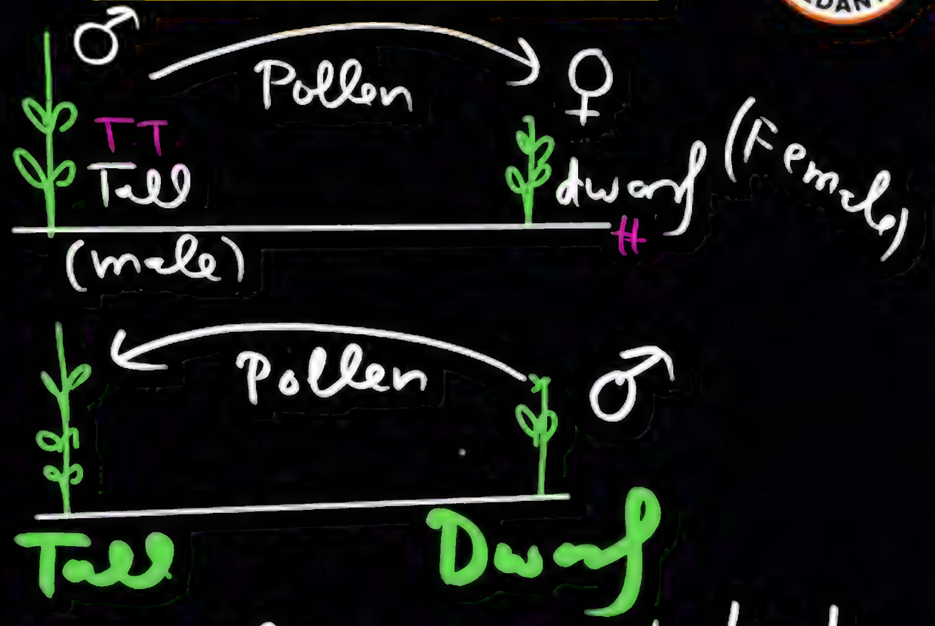
Test cross



- Progeny/offspring Cross with Recessive parent
- Test cross is a type of Back Cross

Use → To Find genotype of Given phenotype

Reciprocal cross



* Mendelian cross no impact of Reciprocal cross
* Useful in cross in drosophila

Principle of inheritance :-

(a) law of Dominance

(b) law of Segregation

Based on his observations on monohybrid crosses Mendel proposed two general rules to consolidate his understanding of inheritance in monohybrid crosses. Today these rules are called the **Principles or Laws of Inheritance:** the First Law or **Law of Dominance** and the Second Law or **Law of Segregation**.

Important Questions

I Find number/type of gametes

(a) Tt

(b) TT

(c) tt

(D) TtRR

(e) Ttrr

(f) TtRr

Observation :-

II Give percentage of Gamete with ⟶ (a) TR
(b) tR
(c) t

in TtRr plant

III Give percentage of pollen TRY in plant TtRrYy

IV Give phenotype of (number)

(a) TT x tt

(b) Tt x Tt

(c) Tt x tt

(d) TtRR x Ttrr

(e) TtRrYY x TtRryy

VI Give phenotype and Genotype no.

(a) $AaBB \times AaBB$

(b) $AaBbCc \times AaBbCc$

(c) $AaBbCc \times aabbcc$

(d) $AaBb \times Aabb$

(e) $AaBBDD \times AaBBDD$

DOPA - 02

Q1 Tt is (a) Phenotype (b) Genotype (c) Both (d) none

Q2 tall and Dwarf in F_2 generation

(a) Both Pure (b) Both not pure (c) Recessive is pure (d) all

Tall (TT, Tt) × tt

Q3 F_1 generation in Mendelian cross

(a) Similar to Both parent (b) Not similar to any parent (c) intermediate of Both (d) none

T × D → F_1 Tall

Violet × white → violet

Q4 Punett square is Graphical Representation of Possible

(a) Progeny (b) Phenotype (c) Genotype (d) Both a & c

Q5 In F_1 generation of Cross B/w pea plant violet (Pure) & white Flower (pure)

(a) all violet (b) 50% violet & 50% white (c) all pure white (d) all white

Q6 Two allele of one character which is contrasting
(a) T & T (b) T & R (c) T & t (d) all

Q7 Which not true About Mendel Factor
(a) occur in pair (b) Segregate during gamete Formation (c) one character many Factor (two) (d) Factors pair Can be contrasting

Tt

Q8 Which is true About allele
(a) it control trait (b) One gene two allele (c) one allele two gene (d) all

Q9 TtRr form gametes
TR Tr tR tr
(a) TT, Tt, TR (b) TR, Tr (c) TR, Rr, Tt, Tr (d) all

Q10 Number of phenotype in Mendelian cross in F1 generation (Monohybrid)
(a) two (b) three (c) one (d) all

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SANKALP NEET VEDANTU

Principle of inheritance and variation

lecture – 01

Botany

TARUN SIR

Class 12th

- SRFP → 3-4Q

- Principles of inheritance ⟶ 5-6 ⟶ 9
- Molecular Basis of inheritance → 6-7Q → 10

Topics

introduction-gene,allele ,chromosome ,haploid,diploid

Mendelian principle- hybridisation experiment,result,law and cross

Gene interaction- incomplete dominance,co-dominance and muliple allele, polygenic inhritance

DOPA prime-1

Chromosomal theory, linkage and sex determination

Dopa prime-2

Mutation,pedigree analysis , genetic disroder

Dopa prime-3

we need to understand

Gene ✓

allele ✓

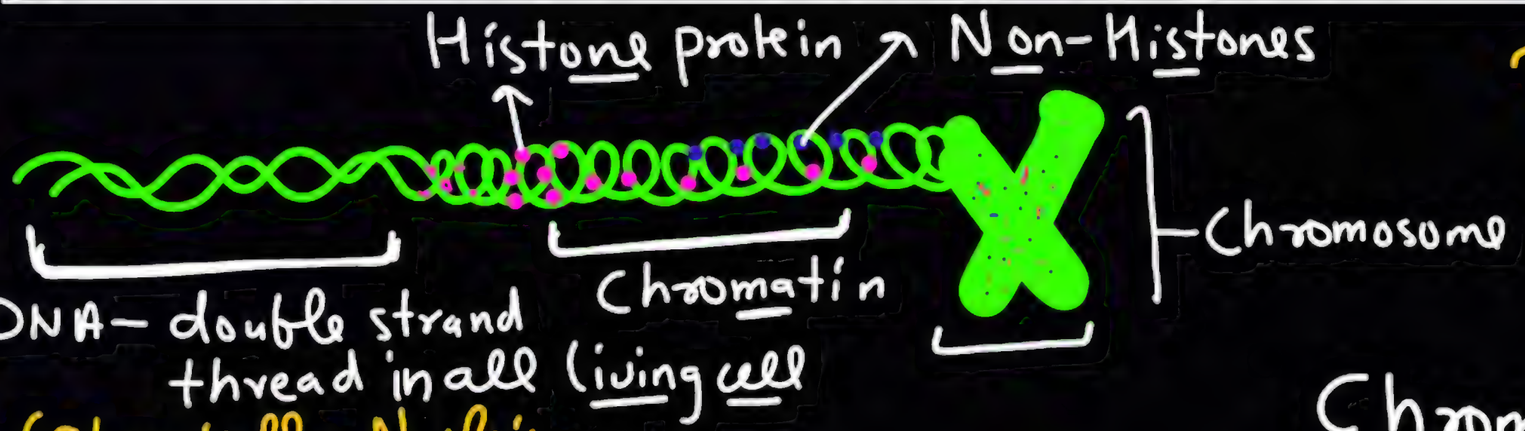
chromosome,chromatin

genome,genotype,gene pool,phenotype

concept of character, ✓

concept of locus ✓

DNA ,chromatin and chromosome



→ DNA – double strand thread in all living cell

→ (Chemically – Nucleic Acid) ✓

→ Charge → – ve ✓

Chromatin → DNA, Protein (Histones, non-Histones) RNA

→ DNA is condensed Form is Chromatin

note – Chromatin & Chromosome in Eukaryotes

– Prokaryote condense DNA is nucleoid

Chromosome – Chromatin Further Condense, During cell Division ✓

Q1 Which is precent in E. coli & Yeast Both

(a) DNA (b) Chromatin

(c) Chromosome (d) all

* In all living cell DNA is Double stranded, it is Genetic material (Gene present)
* In Eukaryotic cell & prokaryotic cell – Both cell show condensation of DNA
* Eukaryotes → DNA → Chromatin → chromosome [Histones present]
* Prokaryotes → DNA condensed to Form nucleoid [Histones Absent] ✓
* Eukaryotes DNA present → At two places → nucleus
  → organelle (Chloroplast ✓ Mitochondria ✓)
* Prokaryotes DNA present → only in cytoplasm – As nucleoid & Plasmid
* DNA is → Double Strand
  - linear DNA → Eukaryotic cell nucleus
  - circular DNA → Prokaryotes Nucleoid, Plasmid
    Eukaryotes organelle

Q2 DNA of Methanogen not true

(a) Double strand (b) have Gene (c) Circular (d) linear

Q3 Which is linear DNA ⟶ It present in nucleus of Eukaryotes

(a) DNA of RBC (b) DNA of nucleus of WBC

(c) DNA of Mitochondria (organelle) (d) DNA of Chloroplast

Concept of gene

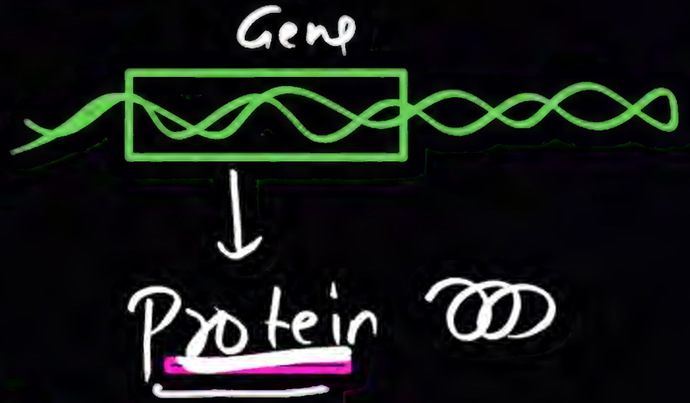
Gene — two type definition

Acc. to Mendelian Genetics → Gene is Unit of inheritance
↳ Smallest Unit → which control Some trait/character

Gene ⟶ Black eye colour

Molecular Genetics → Gene is Segment on DNA which Form one type of protein

DNA - Structure
Gene ⟶ Segment of DNA
Some Function perform



Note - In all living cell → Gene is made up of DNA

DNA - Structure
Gene - Function

XY

Gene = Junk DNA / non-coding DNA

Genetic material ⟶ Sum total of all gene

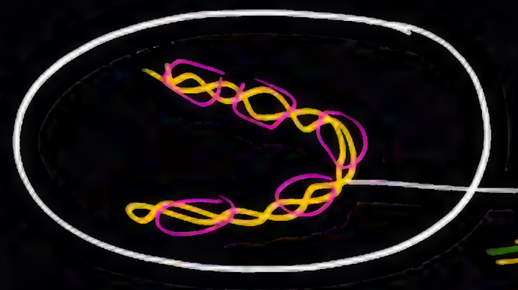
Genome → haploid set of chromosome

Bacteria → Genome & Genetic material is Same

Genotype → Pea plant

Tt — Genotype

(Characters By Gene symbol Represent)



Q Bacterial DNA

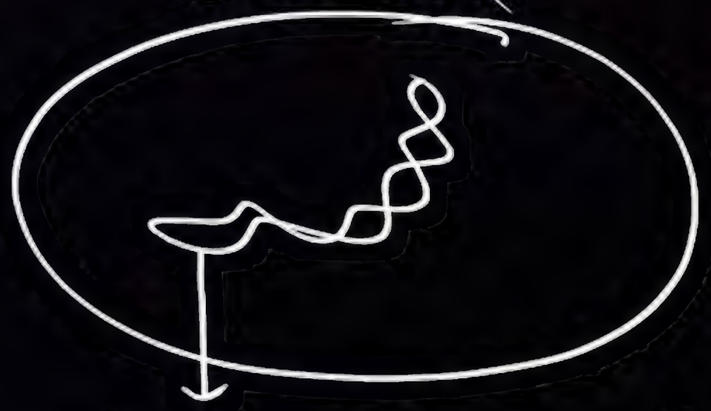
(a) one Gene

(b) two Gene

(c) Genetic material

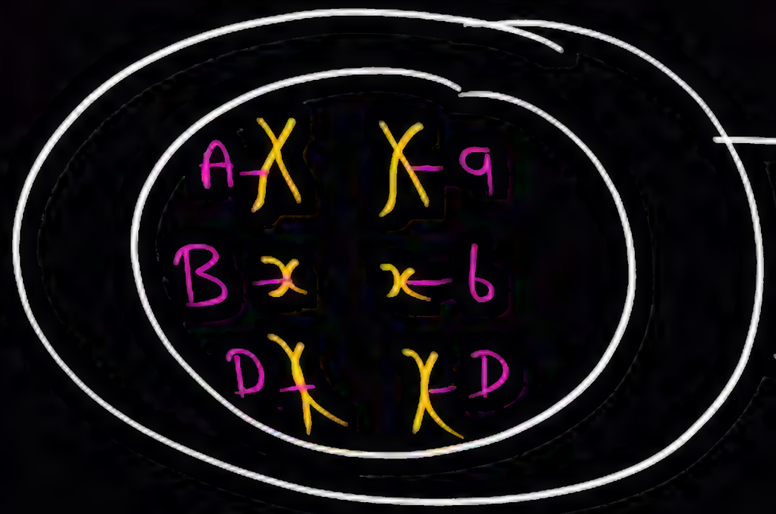
(d) none

Bacterial



1 Chromosome = nucleoid

1o Gene = genetic material = Genome



Eukaryotic cell

↓

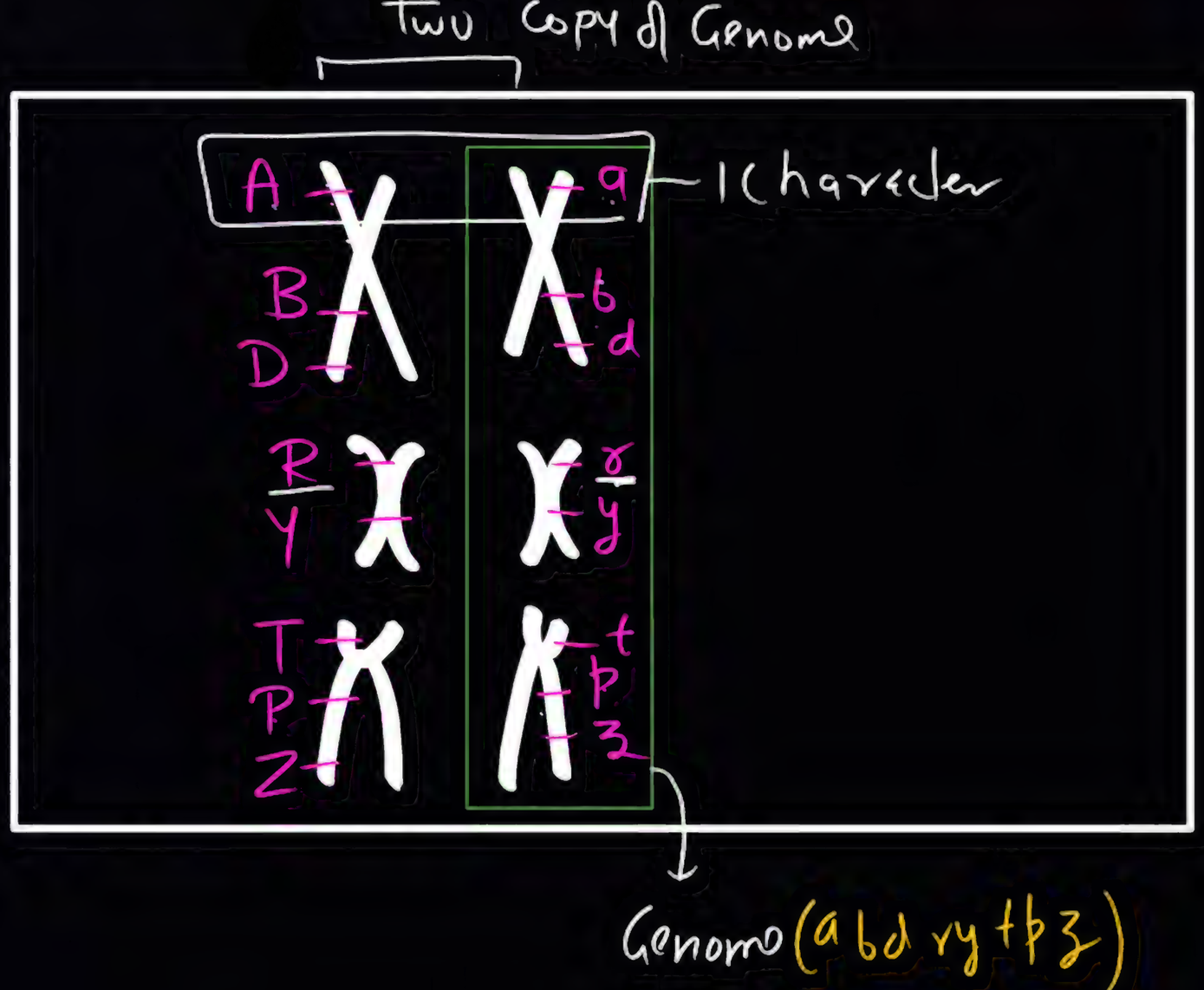
Two copy of genome

Genetic material → A, B, D, d, b, D

all genes

Genome → ABD — Haploid set

Diploid cell → Two copies of Genome



* Genetic – all Genes material on all chromosome

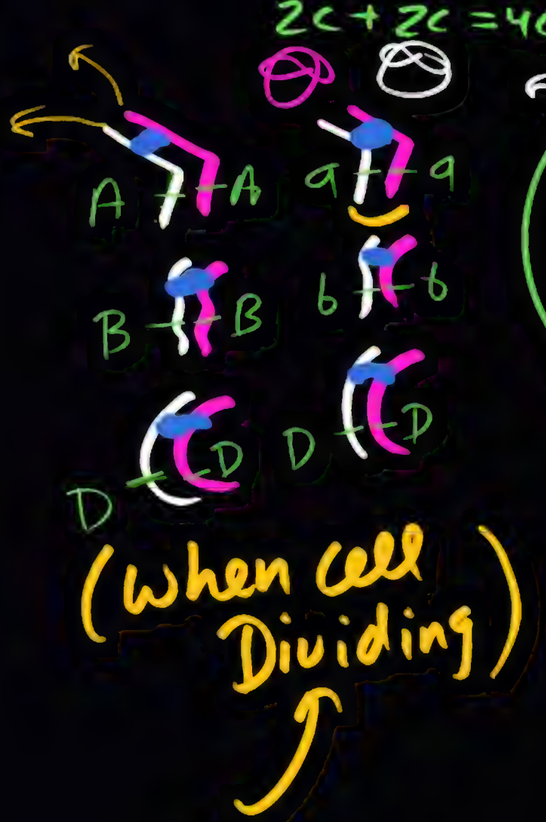
* Genome – all Genes on Haploid set of Chromosome

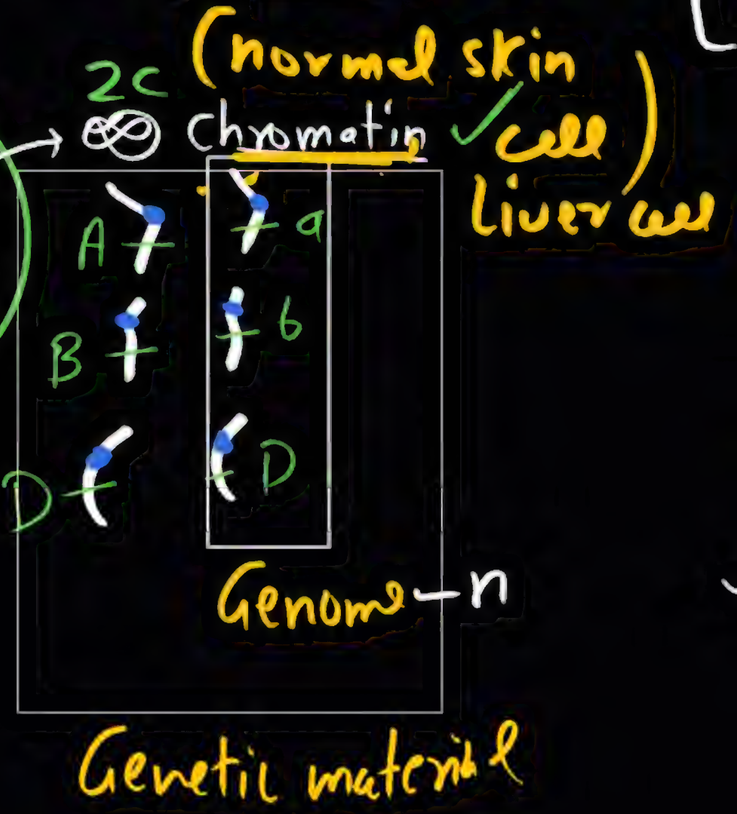
* 1 chromosome – more than one Gene

* Genotype → Aa → Monohybrid
  (AaBb → Dihybrid
  → Representation of some gene)

location of Gene

* Gene is located on DNA, so it is also present on Chromatin & chromosome
* Prokaryotes Gene present on nucleoid





Note → Virus 4 type Genetic material
(ss DNA , ss RNA
ds RNA , ds DNA)

Q Gene is located on
RNA
(a) Few cell
(b) Archaebacteria
(c) all Virus
(d) some Virus

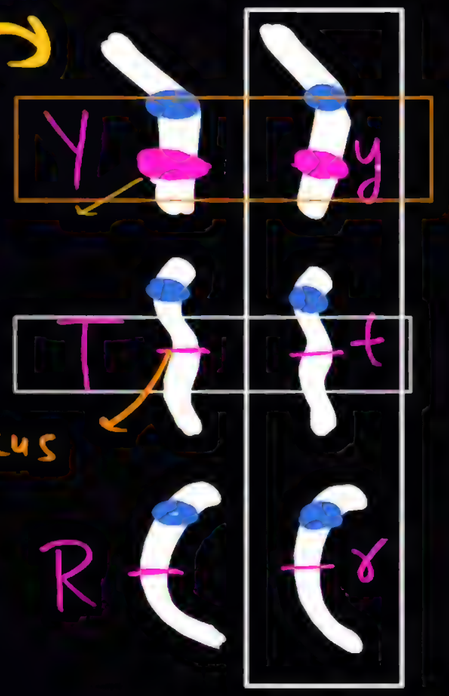
G_1 phase →

1 character = 1 locus

(Seed colour

Yellow Green

Y y



1 locus → For one character

Hapoid — out of one pair, one single Chromosome consider

⇒ y ⟶ haploid — one character

yt → haploid → two character - Different (two locus) (two gene)

y t R → haploid → three Character = three locus (three)

Diploid →

Yy → 1 character (1 locus) = 2 gene

YyTt → 2 character = 4 gene = Diploid (2 locus)

YyTtRr → 3 character = 6 gene - Diploid (3 locus)

Haploid Diploid Triploid | Monohybrid, Dihybrid

Y + y — character = Seed colour

R + r — Characked = Seed shape

T + t — Character — Plant height

1 character consider — Monohybrid → Y or y = Haploid

→ Yy, YY — Diploid

2 Character — Dihybrid → YR → Haploid

YYRr, Yyrr — Diploid

3 Character — Trihybrid → Haploid → TRY, Try

→ Diploid → TtRrYy

One character → Monohybrid

Haploid — T

Diploid → Tt, tt, TT

Triploid → TTT, Ttt, ttt

Two character — Dihybrid

Haploid → TR

Diploid → TtRr, TTRR

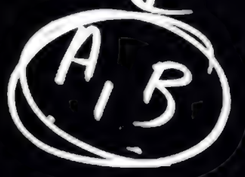
Triploid → TTt RRr

Ttt or rrr

Character	Ploidy
TTRr → 2	2n
TRY → 3	n
TTTRRR → 2	3n
TTTRRRYYY → 3	3n

A = Ab

A Dihybrid plant Can Form Gamete → n → n



(a) A ✗

(b) Ab

(c) AA ✗

(d) BB ✗

DOPA -01

Q1 In a Dihybrid which is true
(a) one locus involve (b) two locus involve (c) two character (d) both b & c

Q2 Which have most gene in skin cell
(a) chromosome (b) Genome (c) Genetic material (d) X-chromosome

Q3 SS DNA have gene in
(a) Prions (b) all virus (c) Viroids (d) Some virus

Q4 Which is Common in Mycoplasma & Yeast cell
(a) have ds DNA (b) RNA as Genetic material (c) have Gene on DNA (d) Both 1 & 3

Q5 TtRr involve
(a) two locus (b) one character (c) Gamete (d) Haploid

Q6 Which is possible Genotype of sperm
(a) Aa (b) AaBb (c) AAA (d) all

Q7 Trihybrid haploid is all Except
(a) AAA (b) bbb (c) Aab (d) Yyy

Q8 Dihybrid Diploid is
(a) Both character Homozygous (b) Both locus Heterozygous (c) Both locus Heterozygous (d) all

Q9 Endosperm genotype can be
(a) TtRr (b) TTT (c) Ttt (d) TtRrYy

Q10 Bacteria have Gene on
(a) Nucleoid (b) Plasmid (c) Organelle (d) Both a&b

How chromatin and chromosome vary

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principle of inheritance

lecture-02

Botany

TARUN SIR

Topics

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Mendelian principle- hybridisation experiment,result,law and cross

Gene interaction- incomplete dominance,co-dominance and muliple allele, polygenic inhritance

DOPA Prime-1

Chromosomal theory, linkage and sex determination

Dopa prime -2

Mutation,pedigree analysis , genetic disroder

Dopa prime -3

DOPA -01

AaBb, AABB

Q1 In a Dihybrid which is true

(a) one locus involve (b) two locus involve (c) two character (d) both b & c

Q2 Which have most gene in skin cell

(a) Chromosome (b) Genome (c) Genetic material (d) X-chromosome

Q3 SS DNA have gene in

(a) Prions (b) all virus (c) viroids (d) some virus

Q4 Which is common in Mycoplasma & Yeast cell

(a) have ds DNA (b) RNA as Genetic material (c) have Gene on DNA (d) Both 1 & 3

Q5 $\overline{T}$ & $\overline{R}$ involve (2n)

(a) two locus (b) one character (c) Gamete (n) (d) Haploid

Q6 Which is possible Genotype of sperm — n

(a) Aa (b) AaBb (c) AAA (d) AB — n

Q7 Trihybrid haploid is all Except - - -

(a) AAA (b) bbb (c) Aab (d) ABD

Q8 Dihybrid Diploid is

(a) Both character Homozygous (b) Both locus Heterozygous (c) One locus Heterozygous (d) all

Q9 Endosperm genotype can be (3n)

(a) TtRr (b) TTT (c) Ttt (d) TtRrYy

Q10 Bacteria have Gene on

(a) Nucleoid (b) Plasmid (c) Organelle (d) Both a & b

n

A | AB | ABC

AaBb AABB AaBB

2n

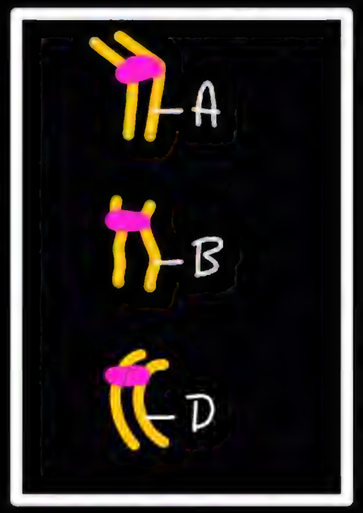
Aa | AaBb | AaBbCc

3n

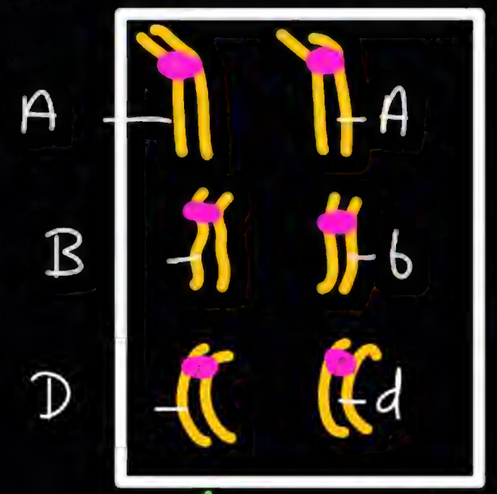
AAA Aa | AAABBB

T T t t

Haploid and Diploid



Haploid



Diploid

Haploid means

(a) Odd no. of chromosome (24 → 48, n → 2n)

(b) Even no. of chromosome

(c) one set of chromosome Each of Different type

(d) all

Q2 Identify Haploid

(a) TR

(b) TT — 2n

(c) TTRR — 2n

(d) Tt — 2n

Q3 Identify Diploid

(a) TR — n

(b) TRY — n

(c) RY — 2n

(d) RRR — 3n

Q4 Identify triploid

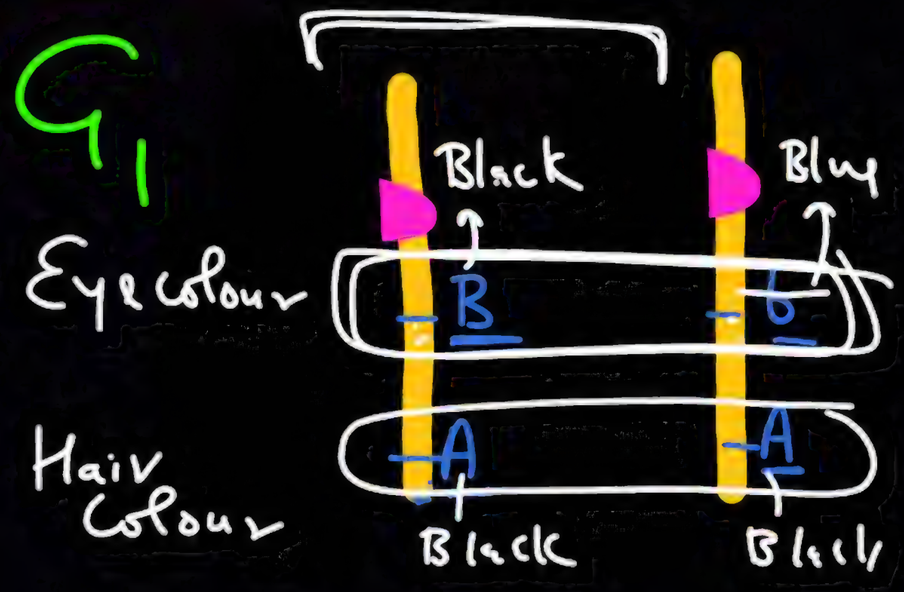
(a) TRY — n

(b) TTRRYY 2n

(c) TTT — 3n

(d) TR — n

Homozygous & Heterozygous & locus



Bb – Heterozygous

AA – Homozygous

Q In Homologus chromosome pair if A & a present on two chomosome then it is

(a) Homozygous

(b) Heterozygous

A 7 7 a

Q One locus means gene of

n → A B C D

2n → Aa Bb Cc Dd

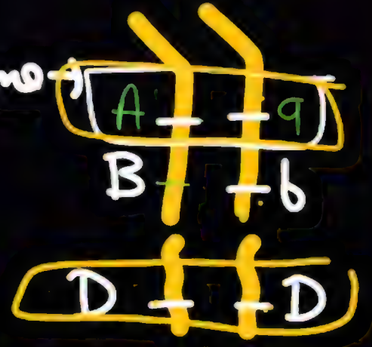
(a) Same Character ✓

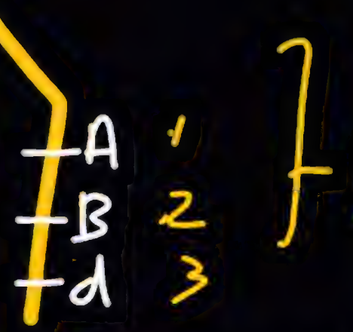
(b) T & R present X

(c) T & t can present ✓

(d) Both a & c

Q Given Diagram of





locus → (a) one (b) two (c) three

Q total Gene → (a) one (b) two (c) three

Q (a) Haploid
(b) Diploid

Q1 No. of locus
(a) one (b) two (c) three (d) Four

Q2 No. of character
(a) one (b) three (c) two (d) Four

Q3 Homozygous locus
(a) one (b) two

Q4 AaBb DD → Represent all Except A
(a) three character (b) Six gene (c) Diploid
X (d) Homozygous Each locus

Genotype — Genetic make up / Genes (Aa, AaBb, TT, t — haploid Genotype)

Diploid Genotype

Phenotype → External Appearance (Ex - tall, Round, Black(-eye))

Homozygous → When one locus two gene → Both Gene similar TT, tt

(For Homozygous → organism Should be Diploid)

A A

heterozygous → when one locus → two gene → Both Gene Disimilar

Tt, Rr

T t

Zygote is Diploid observe

Hemizygous — half → haploid → T → gamete - hemizygous

TR → Hemizygous

TRY → Hemizygous

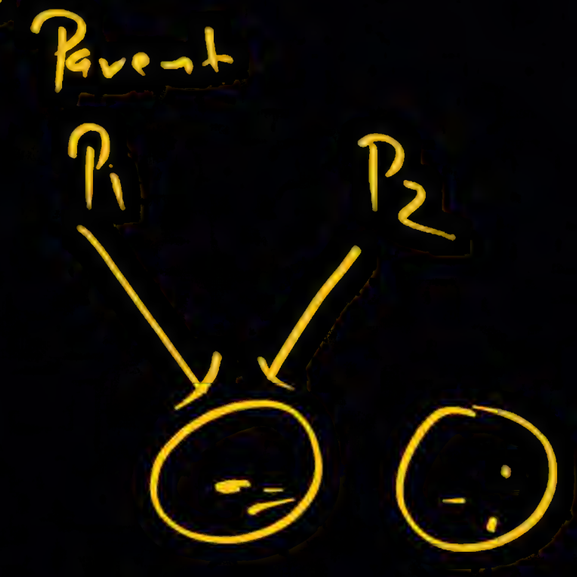
Q Genetics involve

(a) Sexual Reproduction progeny ✓

(b) Asexual Reproduction progeny

(c) Both

(d) none



Q Variation is

(a) Amount of Difference in two parent ✗

(b) Difference in parent & progeny ✓

(c) Progeny of same parents ✓

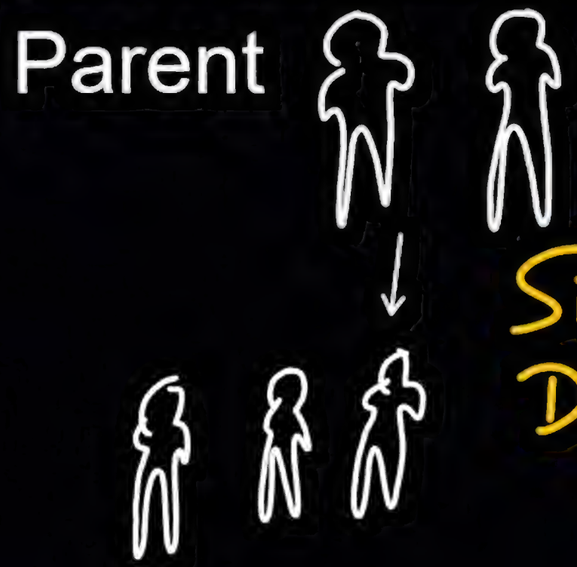
(d) Both b & c ✓

Have you ever wondered why an elephant always gives birth only to a baby elephant and not some other animal? Or why a mango seed forms only a mango plant and not any other plant?

Elephant → Elephant

Mango → Mango

Given that they do, are the offspring identical to their parents? Or do they show differences in some of their characteristics? Have you ever wondered why siblings sometimes look so similar to each other? Or sometimes even so different?

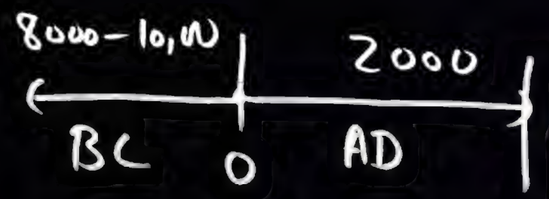


Similarity
Different

Genetics →

These and several related questions are dealt with, scientifically, in a branch of biology known as Genetics. This subject deals with the inheritance, as well as the variation of characters from parents to offspring. Inheritance is the process by which characters are passed on from parent to progeny; it is the basis of heredity. Variation is the degree by which progeny differ from their parents.

Knowledge of genetics



→ 8000-10,000 year old - Agriculture

→ Agriculture ⟶ Use variation of Animals & Plants - in wild varieties

→ Source of variation → Sexual Reproduction (little knowledge of Genetics)

Artificial hybridization & Domestication ➡ Present day Crops Evolve

Ex - Sahiwal Cow - Punjab

Genetics → Pre mendial concepts ⟶ Mixing of trait occur From parent (Blending inheritance)

Genetics → Mendian Concept ⟶

Genetics ↘ Linkage, chromosomal theory

wild cows, we have well-known Indian breeds, e.g., Sahiwal cows in Punjab. We must, however, recognise that though our ancestors knew about the inheritance of characters and variation, they had very little idea about the scientific basis of these phenomena.

Father of Genetics

→ Sisilian village – Austria – Birth place
→ Joined Monastery ⟶ Sent to university of vienna ⟶ Return & Joined Monastery → as a substitute

Experiment – Pea plant – Pisum sativum (Bisexual Flower)

- Year ⟶ 7 year → 1856 – 63 [Hybridization Experiments]
  Work published → 1865 (Unrecognised)

1900 → Carl correns
Erich von Tschemak
Hugo de Vries
} Rediscover Mendel's work

Hybridization Experiments (Plant Breeding Experiment)

Steps → (1) Selection of Parent → in which cross perform

(2) Cross B/w Parent

(3) Observation & Result

(4) Inference → (later develop into law)

Why Mendel work was Different

For cross large sample size — Greater credibility to Result

① large sample size →

② Use mathematical logic → Use Statistical Analysis & Mathematical logic

③ Give General principle → Try to Explain General principle

Rather not try to Explain or Give Unsubstainted data

④ Results – Multiple time check

↳ Repeated Selfing → F_1 F_2 F_3 } For many Generation

Tall X Dwarf

↓

Tall

↓

3 Tall : 1 Dwarf

2990 : 1015

I Selection of parents (First step of Hybridization)

→ Mendel in Pea plant → 14 true breeding variety | Pure line variety select

Differ only in one trait

total → 7 character | 14 varities (14 trait)

True Breeding | Pure = Homozygous

Tall (Pure)
↓ selfing
Tall
↓ selfing
Tall

Character	Dominant trait	Recessive trait	
1. Plant height	Tall	Dwarf	4
2. Flower colour →	Violet	White	1
3. Flower Position →	Axial	Terminal	4
4. Pod shape →	Smooth (Inflated)	Constricted	4
5. Pod colour →	Green	Yellow	5
6. seed shape →	Round	Wrinkled	7
7. seed colour →	Yellow	Green	1

Pea plant → 7 pair (chromosome)
↓
7 characters mendel
Select → 4 chromosome
(4, 1, 5, 7)

Plant height → F → P — S
colour → cl

Q Which is true Breeding
(a) Aa (b) TT (c) Bb
(d) Rr

* Mendel selected those character → two trait (Contrasting → one Dominant one Recessive)

* Some character → Eye colour → More than two trait
(Black, Blue, Brown)

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SANKALP NEET VEDANTU

principle of inheritance

lecture-03

Botany

TARUN SIR

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Mendelian principle- hybridisation experiment,result,law and cross

Gene interaction- incomplete dominance,co-dominance and muliple allele, polygenic inhritance

DOPA Prime-1

Chromosomal theory, linkage and sex determination

Dopa prime -2

Mutation,pedigree analysis , genetic disroder

Dopa prime -3

4.1 Mendel's Laws of Inheritance

It was during the mid-nineteenth century that headway was made in the understanding of inheritance. Gregor Mendel, conducted hybridisation experiments on garden peas for seven years (1856-1863) and proposed the laws of inheritance in living organisms. During

Hybridization Experiment

Steps - ① Parent selection ✓

② Cross ✓

③ Observation ✓

④ Inference ✓

Hybridization Experiments

Selection of parent ⟶ 14 Pure line | true Breeding

7 character ⟶ 14 traits

Pair of Plants – Differ only in one trait

	Dominant	Recessive	
Plant height	Tall	Short	4
Flower colour	Violet	white	1
Position	Axial	terminal	4
Pod shape	Smooth	constricted	4
Pod Colour	Green	Yellow	5
Seed shape	Round	Wrinkled	7
seed Colour	Yellow	Green	1

P
F ⟶ colour

P ⟶ colour

S ⟶ colour

Table 4.1: Contrasting Traits Studied by Mendel in Pea

S.No.	Characters	Contrasting Traits
1.	Stem height	Tall/dwarf
2.	Flower colour	Violet/white
3.	Flower position	Axial/terminal
4.	Pod shape	Inflated/constricted
5.	Pod colour	Green/yellow
6.	Seed shape	Round/wrinkled
7.	Seed colour	Yellow/green

D R D R

Q1 From Following → tall plant, termined Flower, Green pod, Wrinkled seed, White Flower

How Many are Dominant trait

(a) two (b) three (c) Four (d) Five

Q2 Acc. to Mendel, one character have

(a) More than two trait

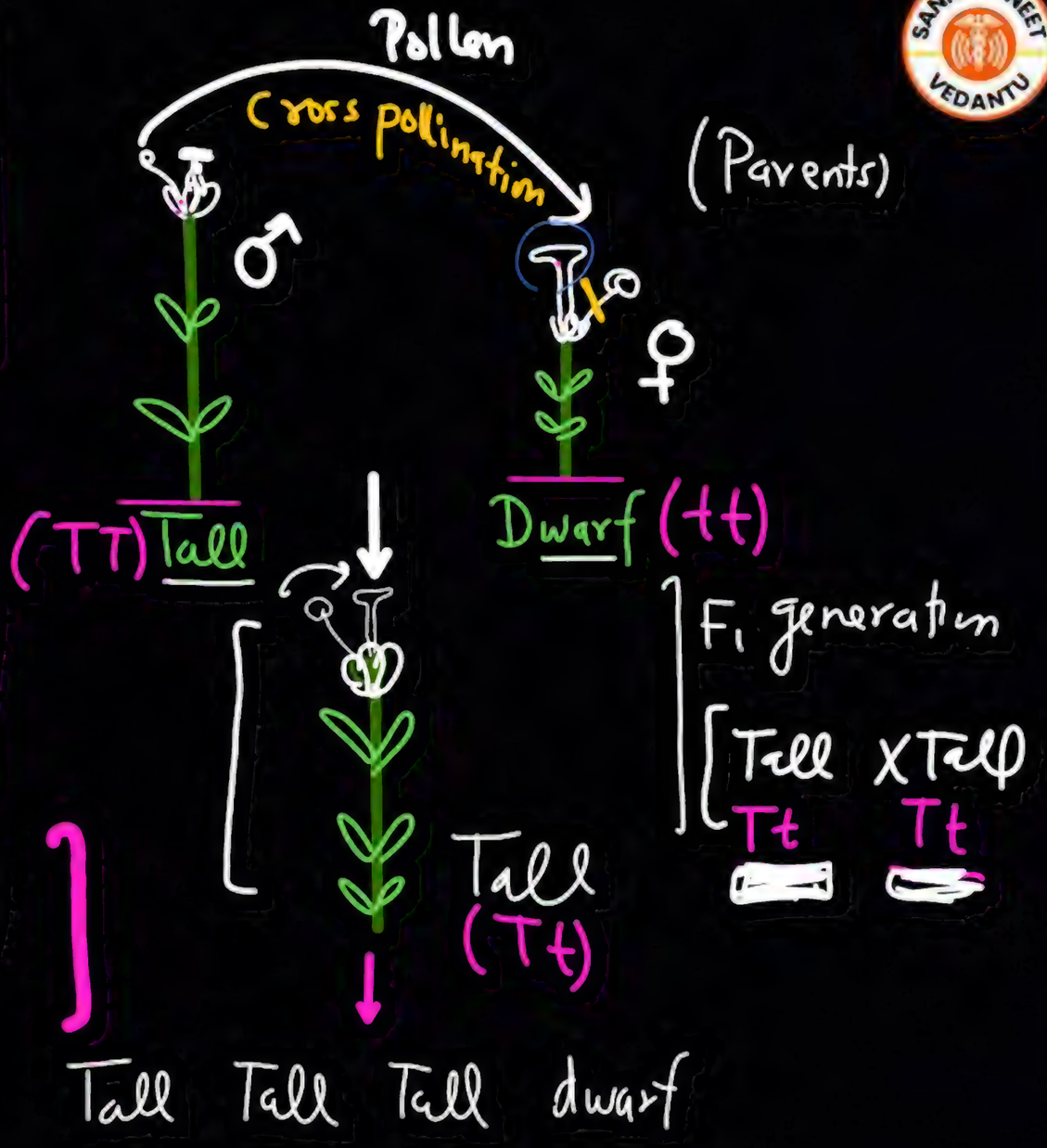
(b) one contrasting trait

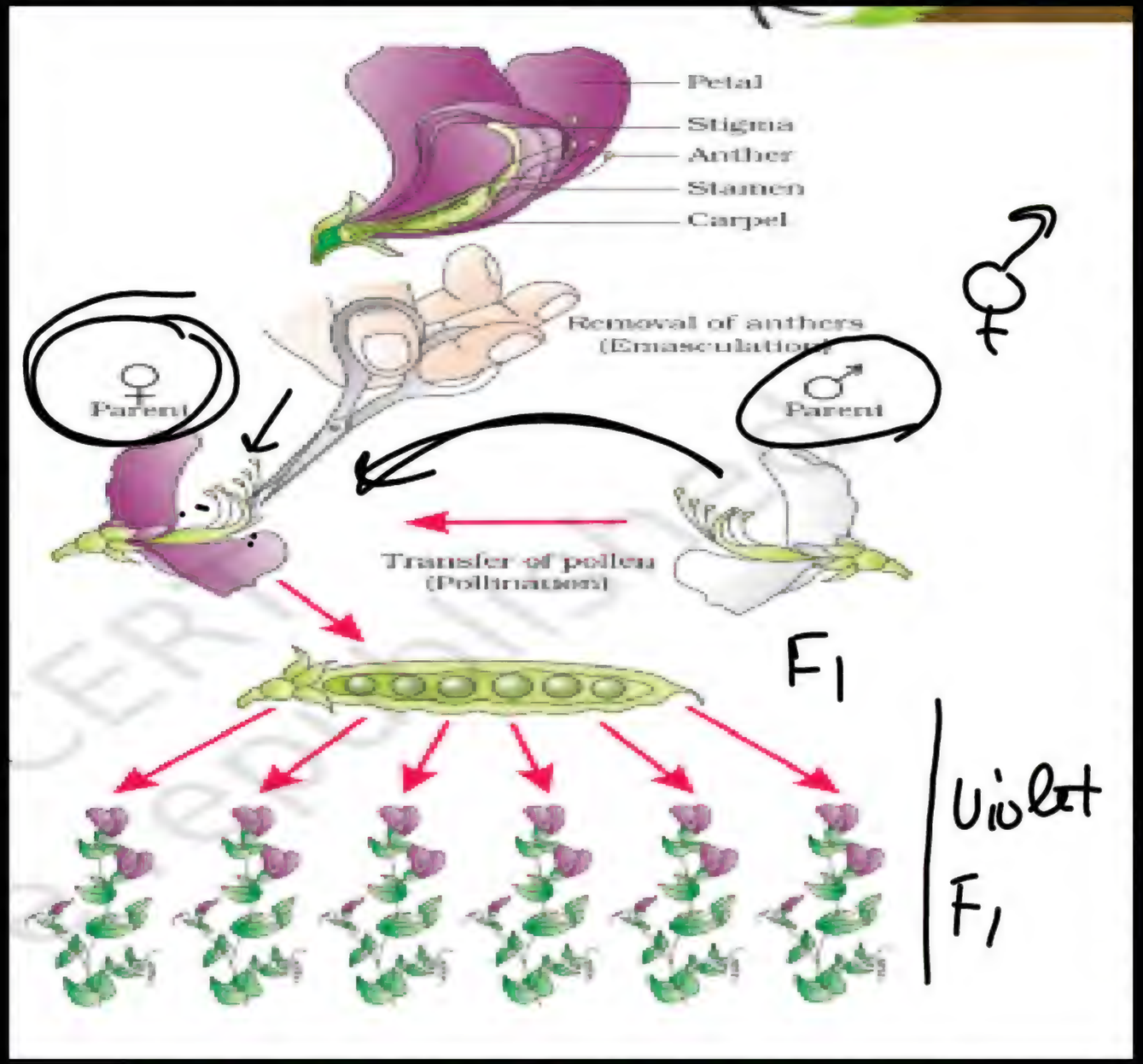
(c) two contrasting traits

(d) all

Cross Between selected parents

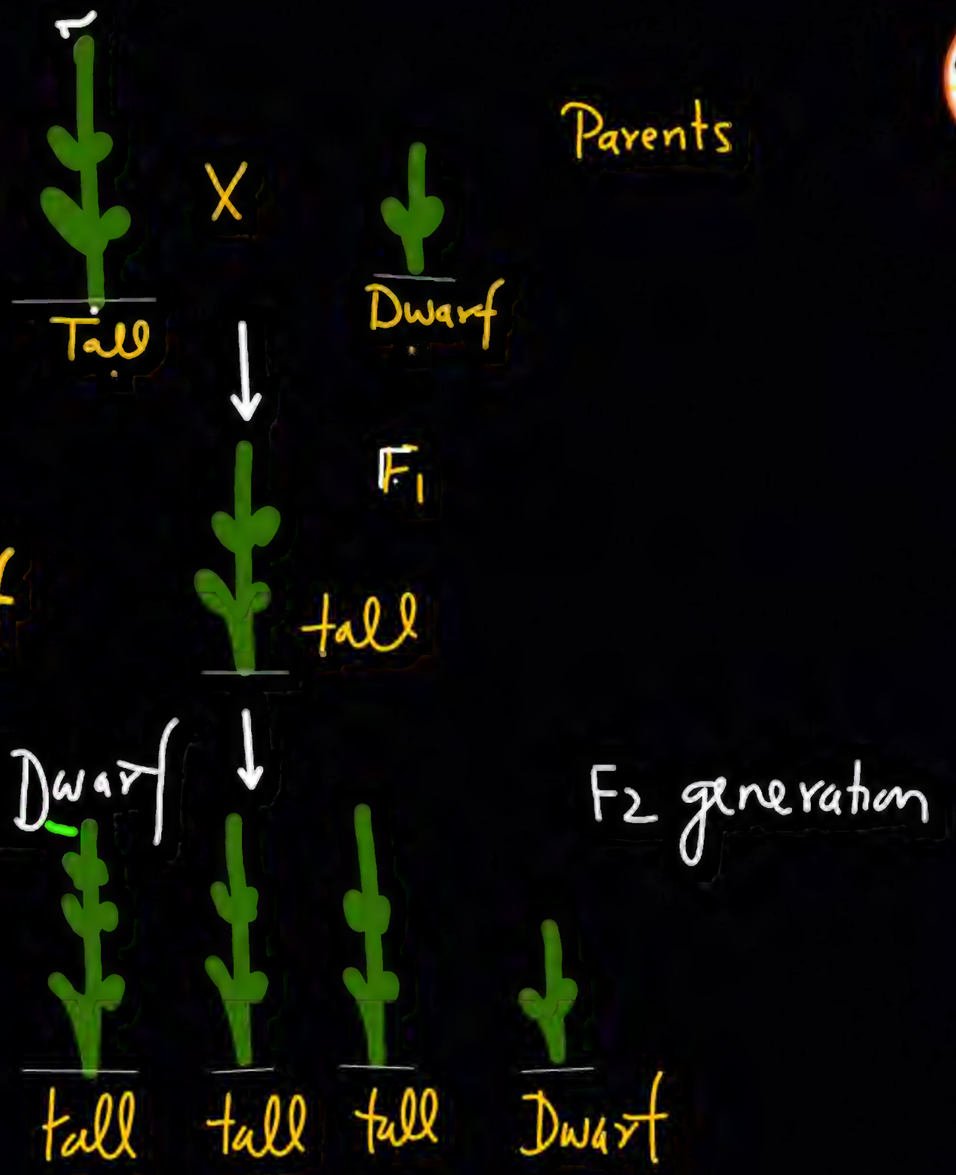
- Pea plant – Bisexual Flower
  (Flower → use Female Flower → Bagging Emasculation
- → Two pure parents → crossed & F_1 Hybrid / Filial I generation
- → Plant of F_1 generation selfing is done (Autogamy, Geitonogamy)
- → Plant of F_2 generation (Both tall, Dwarf)




Petal
Stigma
Anther
Stamen
Carpel
Removal of anthers
(Emasculation)
Parent
Parent
Transfer of pollen
(Pollination)
F1
Violet
F1

Result of cross

- F_1 generation → only tall plant
  - → Resemble any one of the parent Completely
- Selfing of F_1 → F_2 generation, progeny of Both type — tall, dwarf
  - F_2 generation → tall more in number than Dwarf
  - → tall and dwarf → 3 : 1 Ratio



4.2 Inheritance of One Gene

Let us take the example of one such hybridisation experiment carried out by Mendel where he crossed tall and dwarf pea plants to study the inheritance of one gene (Figure 4.2). He collected the seeds produced as a result of this cross and grew them to generate plants of the first hybrid generation. This generation is also called the **Filial$_1$ progeny** or the **F$_1$**. Mendel observed that all the F$_1$ progeny plants were tall, like one of

This generation is also called the **Filial$_1$ progeny** or the **F$_1$**. Mendel observed that all the F$_1$ progeny plants were tall like one of its parents; none were dwarf (Figure 4.3). He made similar observations for the other pairs of traits – he found that the F$_1$ always resembled either one of the parents, and that the trait of the other parent was not seen in them.

Mendel then self-pollinated the tall F$_1$ plants and to his surprise found that in the Filial$_2$ generation some of the offspring were 'dwarf'; the character that was not seen in the F$_1$ generation was now expressed. The proportion of plants that were dwarf were 1/4th of the F$_2$ plants while 3/4th of the F$_2$ plants were tall. The tall and dwarf traits were identical to their parental type and did not show any blending, that is all the offspring were either tall or dwarf, none were of in-between height (Figure 4.3).

Figure 4.2 Steps in making

Similar results were obtained with the other traits that he studied: only one of the parental traits was expressed in the F_1 generation while at the F_2 stage both the traits were expressed in the proportion 3:1. The contrasting traits did not show any blending at either F_1 or F_2 stage.

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Tall T.T × Dwarf tt

↓

Tall (Phenotype)

Tt

↓

F_2

Q F_1 Generation in Mendelian cross

(a) Pure (b) true breeding (c) Homozygous (d) Hybrid ✓

Q F_1 Generation in Mendelian cross

(a) Genotype similar to one parent ×

(b) Phenotype similar to Both parent ×

(c) Phenotype Similar to Any one Parend

(d) Genotype similar to Both parent

Q F_2 Generation is

(a) Result of selfing of F_1

(b) Result of Autogamy & Geitonogamy

tall ♂ tall ♀

Tt TT

(c) Result of cross B/w parent of Similar Genotype

Tt × Tt

(d) all

Inference conclusion

→ Something (Factor) stably passed ⟶ From one Generation to other through gametes

[Something = Factor]
↳ Unit of inheritance
(now it known as Gene)

Tall (TT) ↓ Dwarf (tt) (Pure)

Tall (T) Selfing → Segregation → T, t gamete

Tall (TT) | Tall (Tt) | Tall (Tt) | Dwarf (tt)

Features of Mendelian Factors

(a) Stable (not change)
(b) Discrete (individual)
(c) Occur in pair (organism)
- Pair – Similar → TT, tt
- Pair – Disimilar → Tt

(d) Factors Seperate | Segregate during gamete Formation
(e) One Factor control one trait

Tall (Tt) × Tall (Tt)

T, t gametes | T, t gametes

Q Mendelian Factor is

(a) Unit of inheritance (b) occur in Pair in Individual TT, Tt, tt (c) occur in Pair in Heterozygous (Tt) ~~(d) all~~

Q Mendelian Factor is

(a) Dominant T (b) Recessive t (c) Pass through gamete ~~(d) all~~

Inference

Based on these observations, Mendel proposed that something was being stably passed down, unchanged, from parent to offspring through the gametes, over successive generations. He called these things as 'factors'. Now we call them as **genes**. Genes, therefore, are the units of inheritance. They contain the information that is required to express a particular trait in an organism. Genes which code for a pair of contrasting traits are known as **alleles**, i.e., they are slightly different forms of the same gene.

T – Factor

concept of Allele

- Factor- unit of inheritance

T = Factor (mendel) also gene

t → Factor or gene

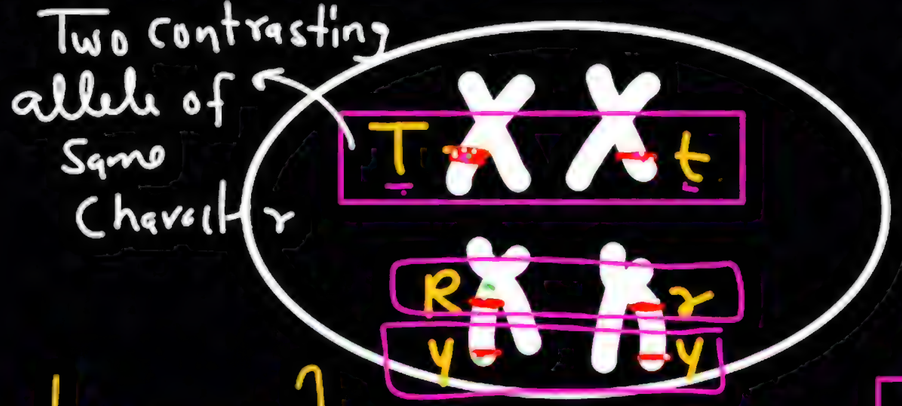
T & t → Two gene locus common [character common]

T & t → two allele of one locus

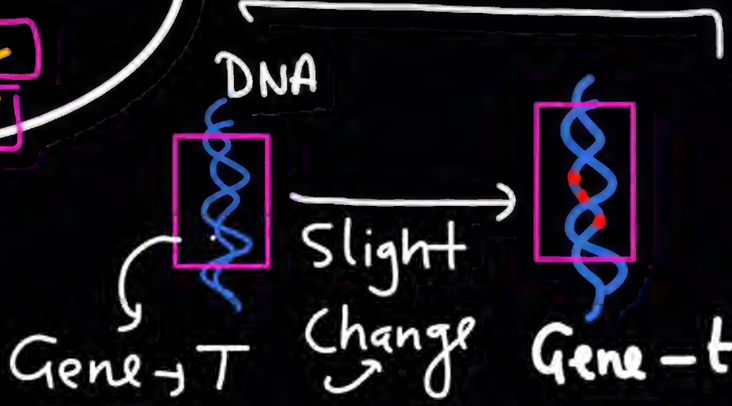
Eye colour (character) → 4 allele

Black eye, Blue, Brown, Green eye

4 Gene and 4 allele



Slight modification of T give t gene



Alleles → T & t (two gene & two allele)

Alleles are those genes which code For contrasting trait

Q T & t are two

(a) Gene (b) Allele (c) Alleles of one character (d) all

Q T & R are two

(a) Gene (b) allele (c) Alleles of two Different character (d) all

Q T & T are two

(a) Similar gene (b) Similar allele (c) Same locus (d) all

Q Y & R have

(a) Different locus (b) two gene of one locus (c) Same locus allele (d) all

Gene Symbol

Plant height - Tall - T - Dominant
Dwarf t - Recessive

I Character with two contrasting trait ⟶

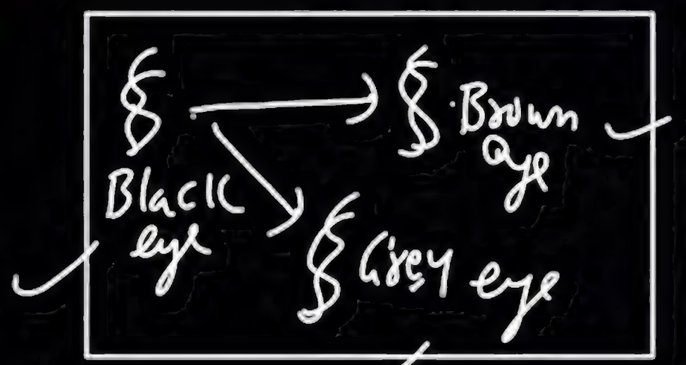
m - miniature wing → Recessive
m^+ - normal wind - Dominant

Drosophila → white eye - Recessive → w
Red eye - Dominant → w^+ (wild type)
yellow Body - Recessive → y
Brown Body → → y^+

II One character → more than two allele — Eye colour (Black eye, Blue, Brown, Grey, Red eye)

I^{Blk} I^{Bly} I^{Brw} I^{Gr} I^{Red}

Blood Group (Character) → I^A, I^B, i — 3 Gene / 3 allele



How Gamete Form

TT → T, T

Type → only T

Tt → T, t — Two type

TtRy → TR, Ty, tR, ty — Four type

TtRy → 2000 pollen → ? pollen → T → 1000

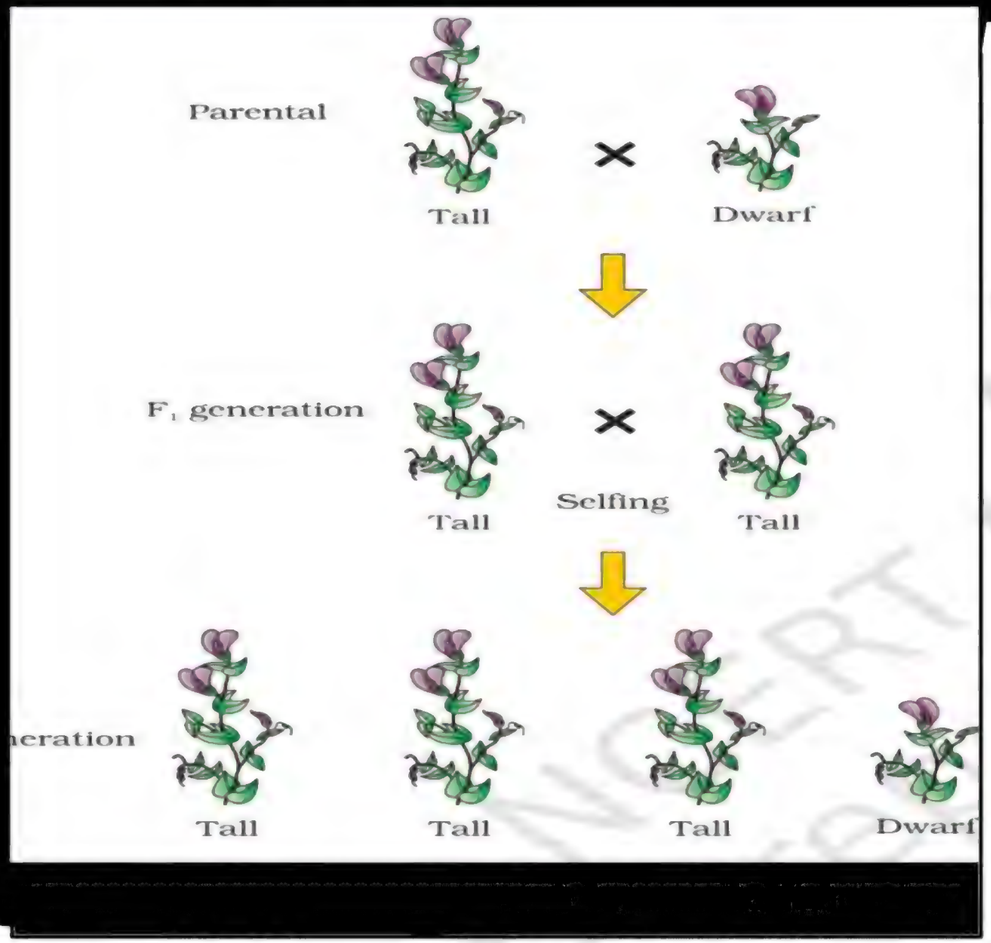
what is segregation

Tt → T, t

(a) occur for two allele of Different Character

TtRy → TR, Ty, tR, ty

~~(b)~~ occur for two allele of same



If we use alphabetical symbols for each gene, then the capital letter is used for the trait expressed at the F_1 stage and the small alphabet for the other trait. For example, in case of the character of height, **T** is used for the Tall trait and **t** for the 'dwarf', and **T** and **t** are alleles of each other. Hence, in plants the pair of alleles for height would be **TT**, **Tt** or **tt**. Mendel also proposed that in a true breeding, tall or dwarf pea variety the allelic pair of genes for height are identical or **homozygous**, **TT** and **tt**, respectively. **TT** and **tt** are called the **genotype** of the plant while the descriptive terms **tall** and **dwarf** are the **phenotype**. What then would be the phenotype of a plant that had a genotype **Tt**?

Type of Mendelian cross

I Monohybrid cross

II Dihybrid cross

III Testcross

Back cross

Reciprocal cross

Monohybrid cross → One character Consider → Ex- Plant Height

Parents (Pure)

Tall TT × Dwarf tt

all F_1 generation tall Tt

↓ selfing

F_2 generation

Tall TT, Tall Tt, Tall Tt, Dwarf tt

* F_1 Generation — Phenotype = tall, Genotype = Tt

* F_2 Generation → Phenotype = 2, tall = 3/4, Dwarf = 1/4

Phenotypic Ratio 3:1

F_2 Generation

Genotype = 3

TT = 1/4

Tt = 2/4

tt = 1/4

Genotypic Ratio:- 1:2:1

Parents

Tall TT × Dwarf tt

F_1

Tall Tt × Tall Tt

F_2

male gamete / Female gamete	T	t
T	TT	Tt
t	Tt	tt

→ Punett square (British — R.C Punett)

- It is Graphical Representation to show possible genotype

- In two side of punett squar gametes Represent

TtR_2 X TTR_2 = 8 Box

4 2

TR

tr

Tr

tR

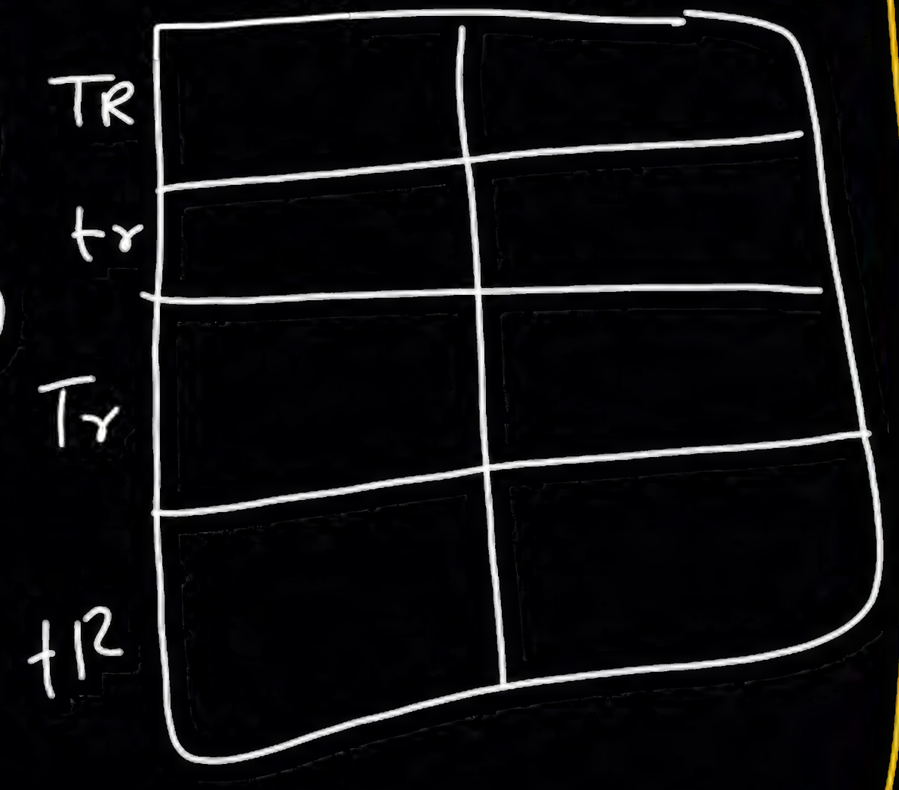
TR

tr

~~Tr~~

Tr

tR



TtR_2 X TtR_2

↓ ↓

4 4

DOPA - 02

Q1 Tt is (a) Phenotype (b) Genotype (c) Both (d) none

Q2 tall and Dwarf in F_2 generation
(a) Both Pure (b) Both not pure (c) Recessive is pure (d) all

Q3 F_1 generation in Mendelian cross
(a) Similar to Both parent (b) Not similar to any parent (c) intermediate of Both (d) none

Q4 Punett square is Graphical Representation of Possible
(a) Progeny (b) Phenotype (c) Genotype (d) Both a & c

Q5 In F_1 generation of Cross B/w pea plant violet (Pure) & white Flower (pure
(a) all violet (b) 50% violet & 50% white (c) all pure white (d) all white

Q6 Two allele of one character which is contrasting
(a) T & T (b) T & R (c) T & t (d) all

Q7 Which not true About Mendel Factor
(a) occur in pair (b) Segregate during gamete Formation (c) one character many Factor (d) Factors pair Can be contrasting

Q8 Which is true About allele
(a) it control trait (b) One gene two allele (c) one allele two gene (d) all

Q9 TtRr Form gametes
(a) TT, Tt, TR (b) TR, Tr (c) TR, Rr, Tt, Tr (d) all

Q10 Number of phenotype in Mendelian cross in F1 generation (Monohybrid)
(a) two (b) three (c) one (d) all

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principle of inheritance

lecture-04

Botany

TARUN SIR

Topics

introduction-gene,allele ,chromosome ,haploid,diploid

Mendelian principle- hybridisation experiment,result,law and cross

Gene interaction- incomplete dominance,co-dominance and muliple allele, polygenic inhritance

DOPA prime-1

Chromosomal theory, linkage and sex determination

Dopa prime-2

Mutation,pedigree analysis , genetic disroder

Dopa prime-3

Type of Mendelian cross

I Monohybrid cross

II Dihybrid cross

III Testcross

Back cross

Reciprocal cross

Monohybrid cross → One character Consider → Ex- Plant Height

Parents (Pure)

Tall TT × Dwarf tt

all F_1 generation tall Tt

↓ selfing

F_2 generation

Tall TT, Tall Tt, Tall Tt, Dwarf tt

* F_1 Generation — Phenotype = tall, Genotype = Tt

* F_2 Generation → Phenotype = 2
  tall = 3/4
  Dwarf = 1/4

Phenotypic Ratio 3:1

F_2 Generation

Genotype = 3

TT = 1/4

Tt = 2/4

tt = 1/4

Genotypic Ratio:- 1:2:1

Parents

Tall TT × Dwarf tt

F_1

Tall Tt × Tall Tt

F_2

male gamete / Female gamete	T	t
T	TT	Tt
t	Tt	tt

→ Punett square (British — R.C Punett)

- It is Graphical Representation to show possible genotype

- In two side of punett squar gametes Represent

$Tt R_2$ X $TT R_2$ = 8 Box

4 2

TR

tr

Tr

tR

TR Tr

TR

tr

Tr

tR

$Tt R_2$ X $Tt R_2$

4 4

Dihybrid cross

TtRr

→ Tall Round

no. of character/locus considered → two

Parents Genotype — Tall Round X Dwarf wrinkled
Phenotype — TT RR — tt rr

Tall wrinkled X Dwarf Round
TT rr — tt RR

Tall Round
TTRR
(one gamete - TR)

Dwarf wrinkled
ttrr (one gamete - tr)

F1 → (Tall Round) (TR, Tr, tR, tr)

F1 Phenotype → 1 (Tall Round)

Genotype → TtRr

type of Gametes By F1 → Four (TR, Tr, tR, tr)

F2 → Phenotype = 4 (Four)

- Tall Round — 9/16
- Tall wrinkled — 3/16
- Dwarf Round — 3/16
- Dwarf wrinkled — 1/16

Phenotypic Ratio — 9:3:3:1

Genotype — 9

Genotypic Ratio → 1:2:2:4:1:2:1:2:1

TR	Tr	tR	tr
TTRR Tall Round	TTRr Tall Round	TtRR Tall Round	TtRr Tall Round
TTRr Tall Round	TTrr Tall wrinkled	TtRr Tall Round	Ttrr Tall wrinkled
TtRR Tall Round	TtRr Tall Round	ttRR Dwarf Round	ttRr Dwarf Round
TtRr Tall Round	Ttrr Tall wrinkled	ttRr Dwarf Round	ttrr Dwarf wrinkled

Dihybrid cross – Two character Tall Round × Dwarf wrinkled

TTRR × tt rr

↓

Tall Round

TtRr (Selfing → TtRr × TtRr) ⇒ 16 Boxes

(4) (4)

TR Tr tR tr

C C

T R

Tt

Tr

tR

TTRR Tall Round	TR Tall Round	TR Tall Round	TR Tall Round
TTRr Tall Round	TTrr Tall wrinkled	TtRr Tall Round	Tall wrinkled
TtRR Tall Round	TtRr Tall Round	ttRR Dwarf Round	ttRr Dwarf Round
TtRr Tall Round	Tall wrinkled	ttRr Dwarf Round	ttrr Dwarf wr

9|16 – tall Round

3|16 tall wrinkled

3|16 Dwf Round

1|16 Dwarf wrinkled

1 : 2 : 2 : 4 1 : 2 1 : 2 : 1

Genotype = 9

Tt

Direct Results of Dihybrid cross

Monohybrid I

Tall TT × Dwarf tt

F_1 → Tall (Tt)

↓ (T+ × Tt)

F_2 Phenotype = 2
- Tall = 3/4
- Dwarf = 1/4

F_2 – Genotype = 3
- TT = 1/4
- Tt = 2/4
- tt = 1/4

Monohybrid II

Round RR × wrinkled rr

Round (Rr)

Selfing ↓ Selfing

Phenotype = 2
- Yellow = 3/4
- Green = 1/4

Genotype = 3
- RR = 1/4
- Rr = 2/4
- rr = 1/4

Dihybrid (two monohybrid)

Tall Yellow × Dwarf Green

↓

F_1 → Tall Yellow (Tt Yy) × Tt Rr

↓

= 4

F_2 – Phenotype
- Tall yellow = 9/16
- Tall Green = 3/16
- Dwarf yellow = 3/16
- Dwarf Green = 1/16

Phenotypic Ration → 9 : 3 : 3 : 1

Genotype = 3 × 3 = 9

- TTRR = 1/16
- TTRr = 2/16
- TTrr = 1/16
- TtRR = 2/16
- TtRr = 4/16
- Ttrr = 2/16
- ttRR = 1/16
- ttRr = 2/16
- ttrr = 1/16

Genotypic Ratio → 1 : 2 : 1 : 2 : 4 : 2 : 1 : 2 : 1

Tall × Dwarf
TT tt
↓
F_1 → Tall (Tt)
↓ selfing
F_2 → Phenotype = 2 ×
Tall = 3/4
Dwarf = 1/4

Genotype = 3
TT = 1/4
Tt = 2/4
tt = 1/4

Round × wrinkled
RR rr
↓
Round (Rr)
↓ selfing
F_2 – Phenotype = 2
Round = 3/4
Wrinkled = 1/4

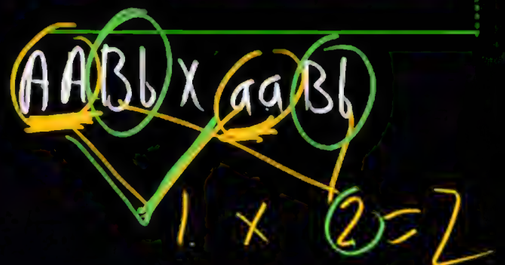
Genotype = 3
RR – 1/4
Rr = 2/4
rr = 1/4

Tall Round × Dwarf wrinkled
↓
Tall Round (TtRr)
↓
F_2 Phenotype = 4
Tall Round = $\frac{3}{4} \times \frac{3}{4} = 9/16$
Tall wrinkled = 3/16
Dwarf Round = 3/16
Dwarf wrinkled = 1/16
9 : 3 : 3 : 1

Genotype = 3 × 3 = 9
TTRR = $1/4 \times 1/4 = 1/16$
TTRr = 2/16
TTrr = 1/16
TtRR = 2/16
TtRr = 4/16
Ttrr = 2/16
ttRR = 1/16
ttRr = 2/16
ttrr = 1/16

TT × tt → 1

	Monohybrid Tall × Dwarf	Dihybrid Tall Round × Dwarf wrinkled	Trihybrid Tall Round yellow × Dwarf wrinkled Green TT RR YY × tt rr yy
F_1 phenotype →	1 (Tall)	1 (Tall Round)	Tall Round yellow
F_1 Genotype →	Tt	TtRr	TtRrYy
F_1 Form gamete →	Two (T, t) $2^1 = 2$	Four (TR, Tr, tR, tr) $2^2 = 4$ ($^nC_2 - n$ = no. of Heterozygous)	Eight → $2^3 = 8$ TRY, TRy, TrY, Try, tRY, tRy, trY, try
F_2 Box (Gamete × gamete)	2 × 2 = 4	4 × 4 = 16	8 × 8 = 64 Box
F_2 phenotype →	2 tall = 3/4 Dwarf = 1/4	4 → 9 : 3 : 3 : 1 Ratio → 9 (1:2:2:4) 1, 2, 1:2:1 3 × 3	8 → 27 genotype (3 × 3 × 3) = Three monohybrid Multiple
Genotype →	(3) (1:2:1)		



AaBbCcDdEe × AaBbCcDdEe → 2 × 2 × 2 × 2 × 2 = 32

2

Questions

(a) TT x tt ⟶ Phenotype → 1 (tall)
Genotype → 1 (Tt)

(b) TT x Tt ⟶ T T t
T → gamete
TT, Tt } 2 genotype
Phenotype = tall

(c) Tt x Tt ⟶ Phenotype = 2
Tt → 2 gamete x 2 gamete
⇒ 4 Box
Genotype = 3
TT, Tt, tt

TtRRYY x Ttrryy
3:1 → 1:2:1

IV TT Rr x tt Rr

Phe → 1 → Tall
Gen → 1 → Tt

Phe = 2
Round = 3/4
Wrinkled = 1/4

Gen → RR = 1/4
Rr = 2/4
rr = 1/4

3

Phe → 2 → Tall Round = 1 x 3/4 = 3/4
Tall wrinkled = 1 x 1/4 = 1/4

Phenotypic Ratio = 3:1

Genotypic → 1:2:1

TtRR = 1/4
TtRr = 2/4
Ttrr = 1/4

Observation:-

1. Gamete Always have one factor out of pair
2. F_1 generation Similar to phenotype of Parents
3. When we multiply two monohybrid cross
   We can get Result of Dihybrid cross

$TtRr \times TtRr$ – 16 Box

$TtRr \times ttrr \rightarrow$ 4 Box
(4 gamete) 1 gamete

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→ Test Cross

→ It is a Mendelian Cross to Find genotype of known phenotype

→ For this, Cross is made with Recessive Parent

Tall (Phenotype) (Unknown genotype) — Two possibility of Genotype

1. Tall (TT) Homozygous × Dwarf (tt) → all tall (100% tall)
2. Tall (Tt) Heterozygous × tt (Dwarf) → Tt – Tall, tt – Dwarf (50% & 50%)

T, t × t

Phenotype = 2 → tall = 1/2, Dwarf = 1/2

Phenotypic Ratio → 1:1

Genotype = 2 → Tt = 1/2, tt = 1/2

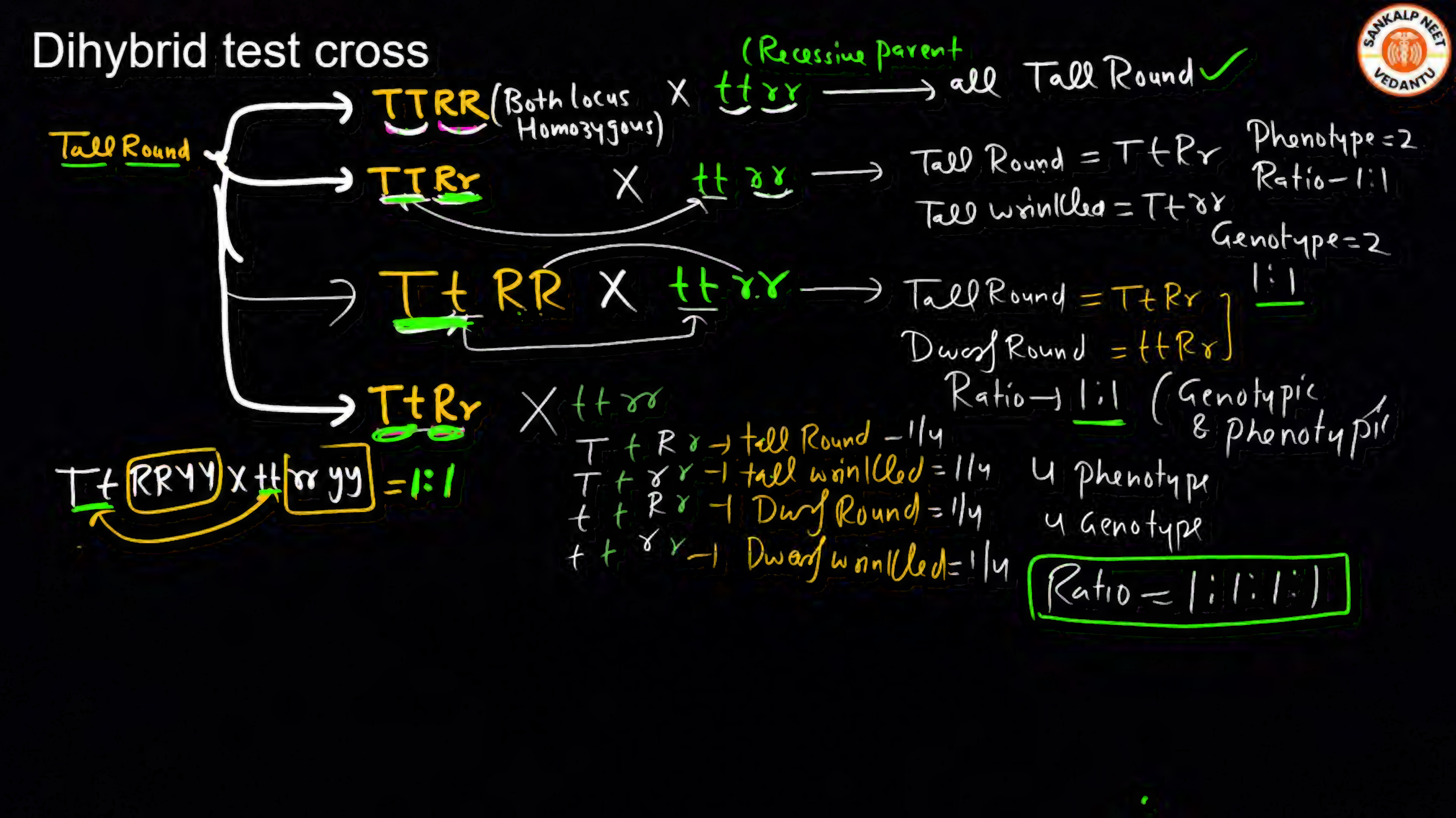
Genotypic Ratio = 1:1

note → Test Cross help to Find

(a) Genotype

(b) Number of gamete

Dihybrid test cross



Observation

(a) Tt X Tt → Phe = 2 → 3:1
Ge – 3

(b) Tt X tt → Phe – 2
Gen – 2] – Ratio – 1:1

(c) Aa BB CC DD X Aa bb cc dd

Phenotype = 2

Phenotypic Ratio = 3:1

(d) Tt RR yy X tt RR yy

Test cross → 1:1

(e) Tt Rr YY ZZ X tt rr yy ZZ

1:1:1:1

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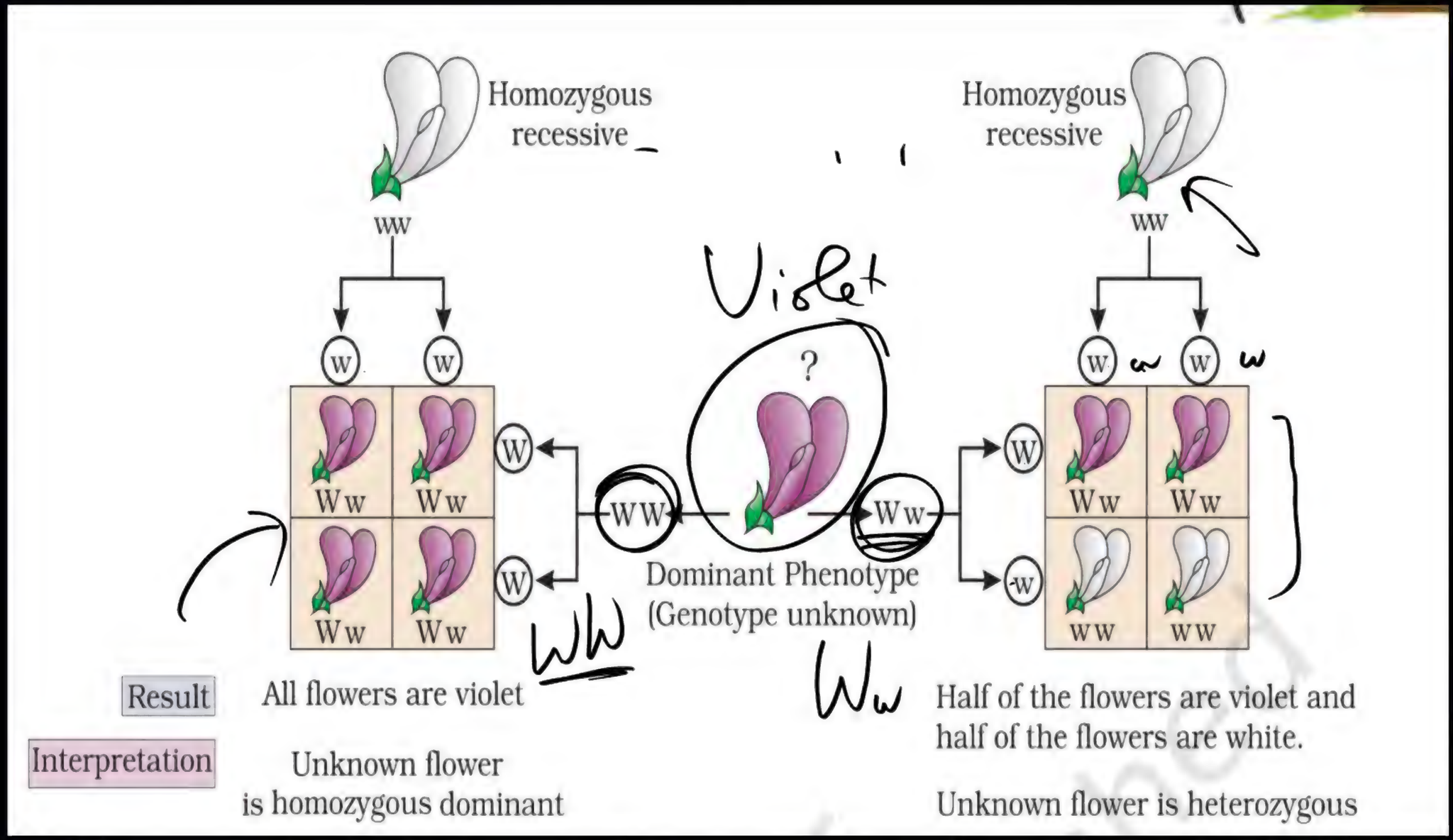
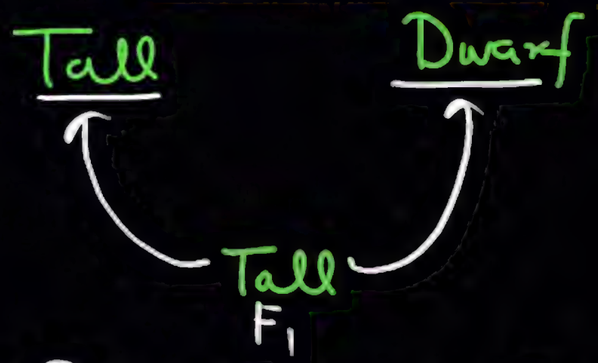

Homozygous recessive
ww
Homozygous recessive
ww
Violet
?
Dominant Phenotype
(Genotype unknown)
WW
Ww
Ww
Ww
Ww
Ww
Ww
Ww
ww
ww
Result
All flowers are violet
Half of the flowers are violet and half of the flowers are white.
Interpretation
Unknown flower is homozygous dominant
Unknown flower is heterozygous

he would have got had he self-pollinated a tall F_2 plant?

From the preceeding paragraphs it is clear that though the genotypic ratios can be calculated using mathematical probability, by simply looking at the phenotype of a dominant trait, it is not possible to know the genotypic composition. That is, for example, whether a tall plant from F_1 or F_2 has **TT** or **Tt** composition, cannot be predicted. Therefore, to determine the genotype of a tall plant at F_2 Mendel crossed the tall plant from F_2 with a dwarf plant. This he called a **test cross**. In a typical test cross an organism (pea plants here) showing a dominant phenotype (and whose genotype is to be determined) is crossed with the recessive parent instead of self-crossing. The progenies of such a cross can easily be analysed to predict the genotype of the test organism. Figure 4.5 shows the results of typical test cross where violet colour flower (W) is dominant over white colour flower (w).

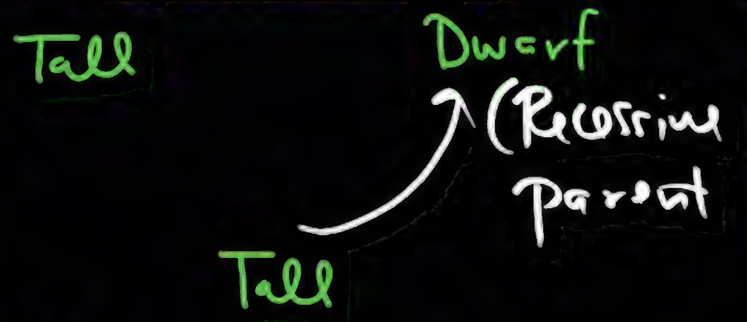
Back cross



- Progeny cross with Any of the parent

Use → Crop improvement

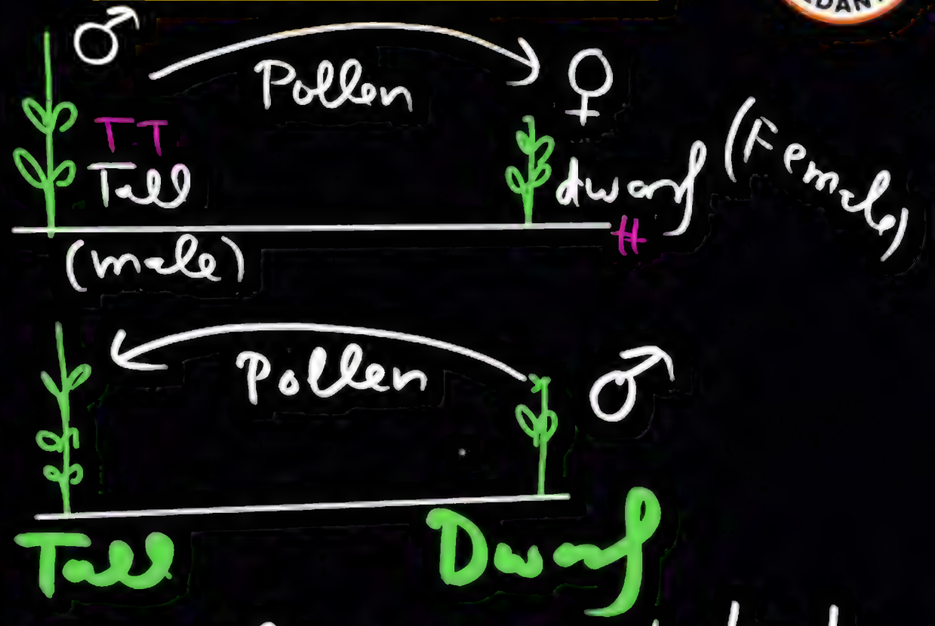
Test cross



- Progeny/offspring Cross with Recessive parent
- Test cross is a type of Back Cross

Use → To Find genotype of Given phenotype

Reciprocal cross



* Mendelian cross no impact of Reciprocal cross
* Useful in cross in drosophila

Principle of inheritance :-

(a) law of Dominance

(b) law of Segregation

Based on his observations on monohybrid crosses Mendel proposed two general rules to consolidate his understanding of inheritance in monohybrid crosses. Today these rules are called the **Principles or Laws of Inheritance:** the First Law or **Law of Dominance** and the Second Law or **Law of Segregation**.

Important Questions

I Find number/type of gametes

(a) Tt

(b) TT

(c) tt

(D) TtRR

(e) Ttrr

(f) TtRr

Observation :-

II Give percentage of Gamete with ⟶ (a) TR
(b) tR
(c) t

in TtRr plant

III Give percentage of pollen TRY in plant TtRrYy

IV Give phenotype of (number)

(a) TT x tt

(b) Tt x Tt

(c) Tt x tt

(d) TtRR x Ttrr

(e) TtRrYY x TtRryy

VI Give phenotype and Genotype no.

(a) $AaBB \times AaBB$

(b) $AaBbCc \times AaBbCc$

(c) $AaBbCc \times aabbcc$

(d) $AaBb \times Aabb$

(e) $AaBBDD \times AaBBDD$

DOPA - 02

Q1 Tt is (a) Phenotype (b) Genotype (c) Both (d) none

Q2 tall and Dwarf in F_2 generation

(a) Both Pure (b) Both not pure (c) Recessive is pure (d) all

Tall (TT, Tt) × tt

Q3 F_1 generation in Mendelian cross

(a) Similar to Both parent (b) Not similar to any parent (c) intermediate of Both (d) none

T × D → F_1 Tall

Violet × white → violet

Q4 Punett square is Graphical Representation of Possible

(a) Progeny (b) Phenotype (c) Genotype (d) Both a & c

Q5 In F_1 generation of Cross B/w pea plant violet (Pure) & white Flower (pure)

(a) all violet (b) 50% violet & 50% white (c) all pure white (d) all white

Q6 Two allele of one character which is contrasting
(a) T & T (b) T & R (c) T & t (d) all

Q7 Which not true About Mendel Factor
(a) occur in pair (b) Segregate during gamete Formation (c) one character many Factor (two) (d) Factors pair Can be contrasting

Tt

Q8 Which is true About allele
(a) it control trait (b) One gene two allele (c) one allele two gene (d) all

Q9 TtRr form gametes
TR Tr tR tr
(a) TT, Tt, TR (b) TR, Tr (c) TR, Rr, Tt, Tr (d) all

Q10 Number of phenotype in Mendelian cross in F1 generation (Monohybrid)
(a) two (b) three (c) one (d) all

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principle of inheritance

lecture-05

Botany

TARUN SIR

Topics

introduction-gene,allele ,chromosome ,haploid,diploid

Mendelian principle- hybridisation experiment,result,law and cross

Gene interaction- incomplete dominance,co-dominance and muliple allele, polygenic inhritance

DOPA prime-1

Chromosomal theory, linkage and sex determination

Dopa prime-2

Mutation,pedigree analysis , genetic disroder

Dopa prime-3

Principle of inheritance :-

Two General rule which is known as principle of inheritance

(a) law of Dominance — First law

(b) law of Segregation → Second law
(Purity of Gametes)

Based on his observations on monohybrid crosses Mendel proposed two general rules to consolidate his understanding of inheritance in monohybrid crosses. Today these rules are called the **Principles or Laws of Inheritance:** the First Law or **Law of Dominance** and the Second Law or **Law of Segregation**.

Mendel's law

law of Dominance – Trait is controlled By Discrete Unit is called Factor
– Factor occur in pairs
– In Disimilar pair (Tt) → only one Factor Express its completely known as Dominant Factor other is Recessive

Trait → control By → Factor → occur in pair → Disimilar pair → one Express

Tt – Dis similar pair
tt – Similar pair
TT

This law Explains → (a) Why F1 generation Resemble only one parent Completely
(b) Why in F2 Ratio is 3:1

Q law of Dominance Proof with Result
(a) F1 (b) F2 (c) Both
(d) none

4.2.1 Law of Dominance

(i) Characters are controlled by discrete units called **factors**.

(ii) Factors occur in pairs.

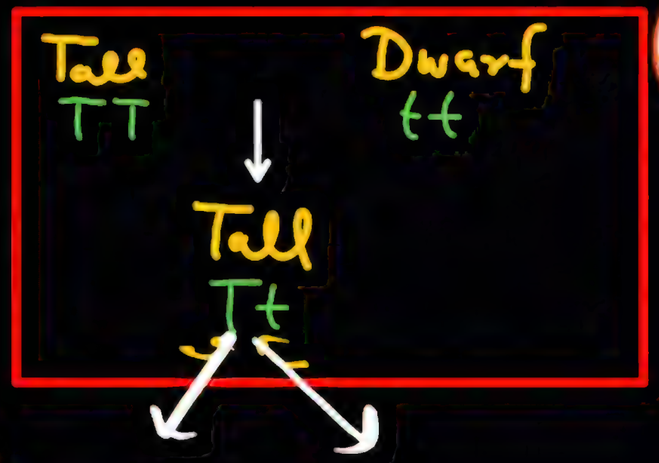
(iii) In a dissimilar pair of factors one member of the pair dominates (dominant) the other (recessive).

The law of dominance is used to explain the expression of only one of the parental characters in a monohybrid cross in the F_1 and the expression of both in the F_2. It also explains the proportion of 3:1 obtained at the F_2.

Law of segregation

Segregate → two Factors Seperate

→ Factors of two trait (Tt) ⟶ not show Any Blending and Segregate At time of Gamete Formation



→ In Such a manner → Each gamete Recieve one Factor Out of pair

Tt → pair ⟶ 100 gamete
50 gamet → T
50 gamete → t

Monohybrid

TT ⟶ 100% gamete only → (T)

tt ⟶ 100% gamete only → (t)

Tt — Disimilar pair ⟶ 50% (T)
50% (t)

TtRr ⟶ 50% → T
50% → t

(Dihybrid)

(TR)
(Tr)
(tR)
(tr)

Gametes are pure For Character

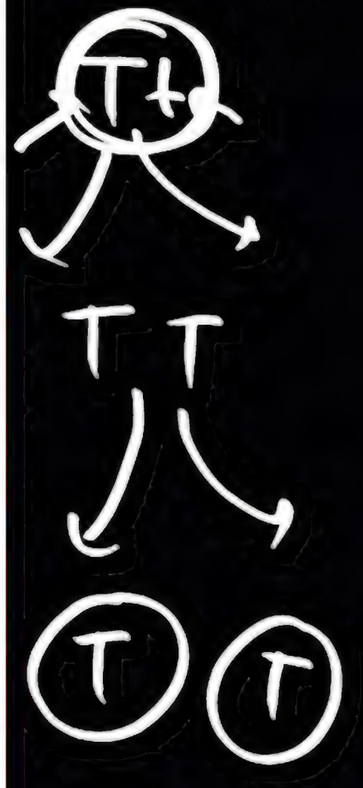
Tt → Zygote

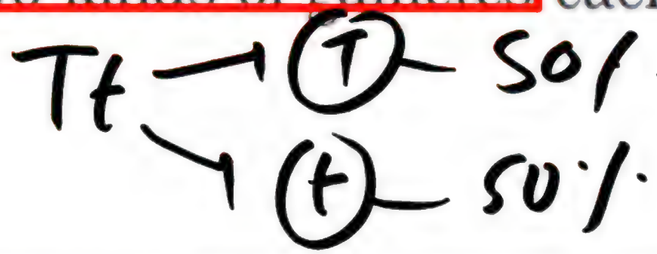
(T) - gamete → Pure (only one trait)

(t) → gamete → Pure

4.2.2 Law of Segregation

This law is based on the fact that the alleles do not show any blending and that both the characters are recovered as such in the F_2 generation though one of these is not seen at the F_1 stage. Though the parents contain two alleles during gamete formation, the factors or alleles of a pair segregate from each other such that a gamete receives only one of the two factors. Of course, a homozygous parent produces all gametes that are similar while a heterozygous one produces two kinds of gametes each having one allele with equal proportion.





Important Questions

I Find number/type of gametes

(a) $Tt \rightarrow (2)$ — T, t

(b) $TT \rightarrow 1$ — (T)

(c) $tt \rightarrow (1)$ — t

(D) $\overline{Tt\,RR} \rightarrow 2^1 = 2$ — n = no. of Heterozygous

T → R, t → R

TR, tR

(e) $Tt\,rr \rightarrow 2^1 = 2$

T → r, t → r

Tr, tr

(f) $\underline{Tt}\,Rr$

$2^2 = 4$ (4)

T → R, r; t → R, r

TR, Tr, tR, tr

(g) $\underline{Tt}\,\underline{Rr}\,\underline{Yy}$ — n = 3

$2^3 = 8$

TRY, TRy, TrY, Try, tRY, tRy, trY, try

(h) $\overline{Tt}\,\underline{RR}\,\underline{Yy} \rightarrow$

$2^2 = 4$

T → R, Y, y; t → R, Y, y

TRY, TRy, tRY, tRy

II Give percentage of Gamete with ⟶ (a) TR — 25%. in TtRr plant
(b) tR — 25%.
(c) t — 50%.

YyRrZz

YRZ → ?. $\frac{1}{2} \times \frac{1}{2} \times \frac{1}{2} = \frac{1}{8} = 12.5\%$.

TtRrYy

↓

Try → $\frac{1}{2} \times \frac{1}{2} \times \frac{1}{2} = 12.5\%$.

TR
Tr
tR
tr

III Give percentage of pollen TRY in plant TtRrYy

$\frac{1}{2} \times \frac{1}{2} \times \frac{1}{2} = 12.5\%$.

TtRrYY

TRY? → $\frac{1}{2} \times \frac{1}{2} \times 1$

$= \frac{1}{4} = 25\%$.

(IV) Plant Genotype → TtRRYYZz ⟶ % of Gamete → TRYZ

$\frac{1}{2} \times 1 \times 1 \times \frac{1}{2} = \frac{1}{4} = 25\%$

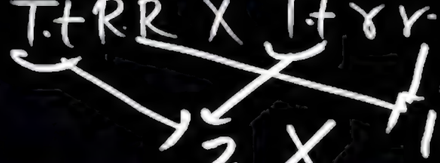
IV Give phenotype of (number)

(a) TT x tt → Tt – tall — 100% tall — Phenotype = 1

(b) Tt x Tt (Selfing) — tall = 3/4, Dwarf = 1/4 — Phenotype = 2, 3 : 1

(c) Tt x tt (Test cross) → tall = 1/2, Dwarf = 1/2 — Phenotype = 2, 1 : 1

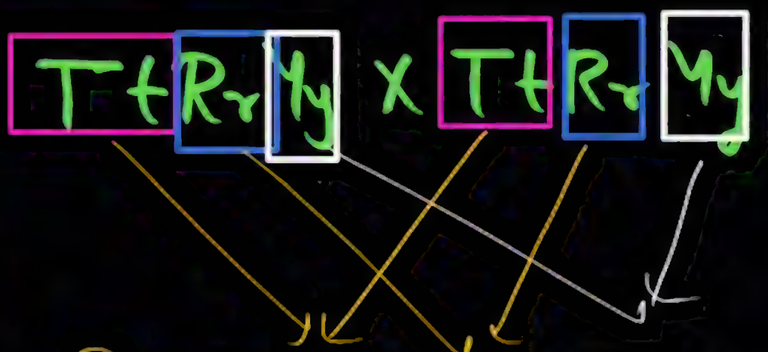
(d) TtRR X TtYy



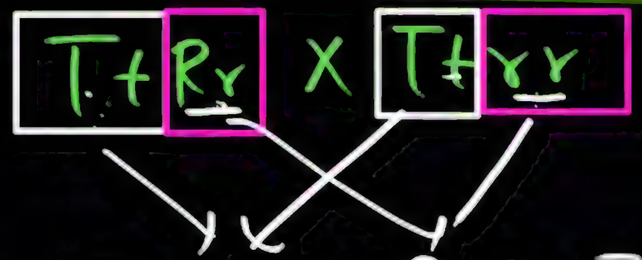
2 X 1 = 2 phenotype — tall Round, Dwarf Round

(e) TtRrYy X TtRryy

2 x 2 x 1 = 4



P = 2 x P = 2 x P = 2 = 8



P = 2 x P = 2 = 4

tall = 3/4, Dwarf = 1/4 — Round = 1/2, wrinkled = 1/2

tall Round	tall wrinkled	Dwarf Round	Dwarf wrinkled
3/8	3/8	1/8	1/8

3 : 3 : 1 : 1

VI Give phenotype and Genotype no.

(a) Aa BB X Aa BB

P = 2 × P = 1 ⇒ 2
G = 3 × G = 1 ⇒ 3

(b) Aa Bb Cc X Aa Bb Cc

P = 2 × P = 2 × P = 2 → 8 = P
G = 3 × G = 3 × G = 3 → 27 = G

(c) Aa Bb Cc X aa bb cc

P = 2 P = 2 P = 2 → P = 8
G = 2 G = 2 G = 2 → G = 8

(d) Aa Bb X Aa bb

P = 2 P = 2 → P = 4
G = 3 G = 2 → G = 6

(e) Aa BB DD X Aa BB DD

P = 2 × P = 1 × P = 1
G = 3 × G = 1 × G = 1

P = 2
G = 3

Gene interaction → Two Factor/two allele of one locus can interact [Monohybrid Cross

of one Gene locus

Dominance → One Gene product Supress Another Gene produt of same locus
(Acc to Mendel)

F_2 – Genotype = 3
F_2 → phenotype = 2

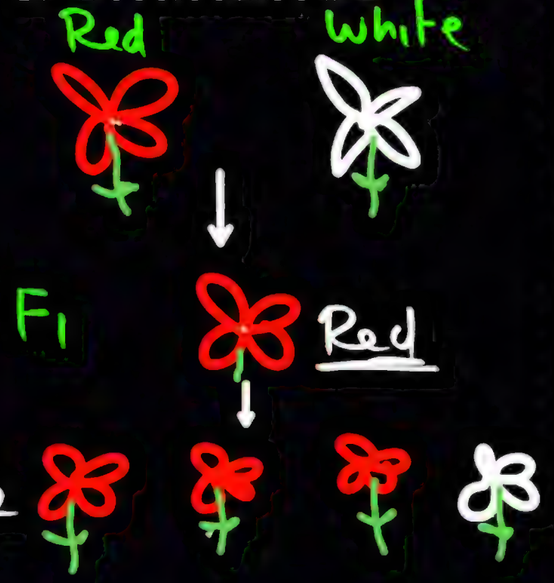
- incomplete dominance
- Co dominance
- Multiple allele
- Pleiotropy

not Acc. to Mendel (no. of phenotype get change F_2)

One gene locus involve

(Deviation of Mendelism)

Dominance



$F_1 \rightarrow$ Completely Resemble Any of the parent

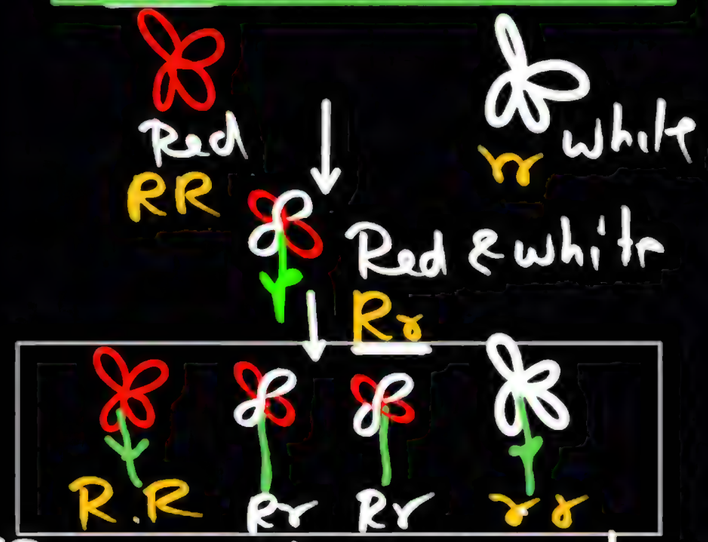
$F_2 \rightarrow$ Phenotype = 2
Genotype = 3

Incomplete dominance

F_1 — intermediate of Both Parent

$F_2 \rightarrow$ Phenotype = 3
Genotype = 3

Co dominance



$F_1 \rightarrow$ match trait of Both Parent

$F_2 \rightarrow$ Genotype = 3
Phenotype = 3

not Follow Mendel's law of Dominance

4.2.2.1 Incomplete Dominance

When experiments on peas were repeated using other traits in other plants, it was found that sometimes the F_1 had a phenotype that did not resemble either of the two parents and was in between the two. The inheritance of flower colour in the dog flower (snapdragon or *Antirrhinum sp.*) is a good example to understand incomplete dominance. In a cross between true-breeding red-flowered **(RR)** and true-breeding white-flowered plants **(rr)**, the F_1 **(Rr)** was pink (Figure 4.6). When the F_1 was self-pollinated the F_2 resulted in the following ratio 1 **(RR)** Red : 2 **(Rr)** Pink : 1 **(rr)** White. Here the genotype ratios were exactly as we would expect in any mendelian monohybrid cross, but the phenotype ratios had changed from the 3:1 dominant : recessive ratio. What happened was that **R** was not completely dominant over **r** and this made it possible to distinguish **Rr** as pink from **RR** (red) and **rr** (white).

Incomplete dominance

definition → F_1 Generation is intermediate of Both Parent

Some Examples nature not Follow Mendel's Dominance

Example → Snapdragon | Antirhinum majas

4'o clock plant | Mirabilis Jalapa

(Both show → Flowe → Red, white, Pink)

* F_1 → intermediate Phenotype = 1, Genotype = Rr

F_2 → Phenotype = 3, Genotype = 3 } Equal

Pure Parent

Red RR × white rr

↓

Pink Flower (F_1) Rr

↓ Selfing

	R	r
R	RR Red	Rr Pink
r	Rr Pink	rr white

(three) ✓

Phenotype → Red → 1/4 Pink = 2/4 white = 1/4

Phenotypic Ratio = 1 : 2 : 1

Genotype (3) → RR = 1/4 Rr = 2/4 rr = 1/4

Ratio → 1 : 2 : 1

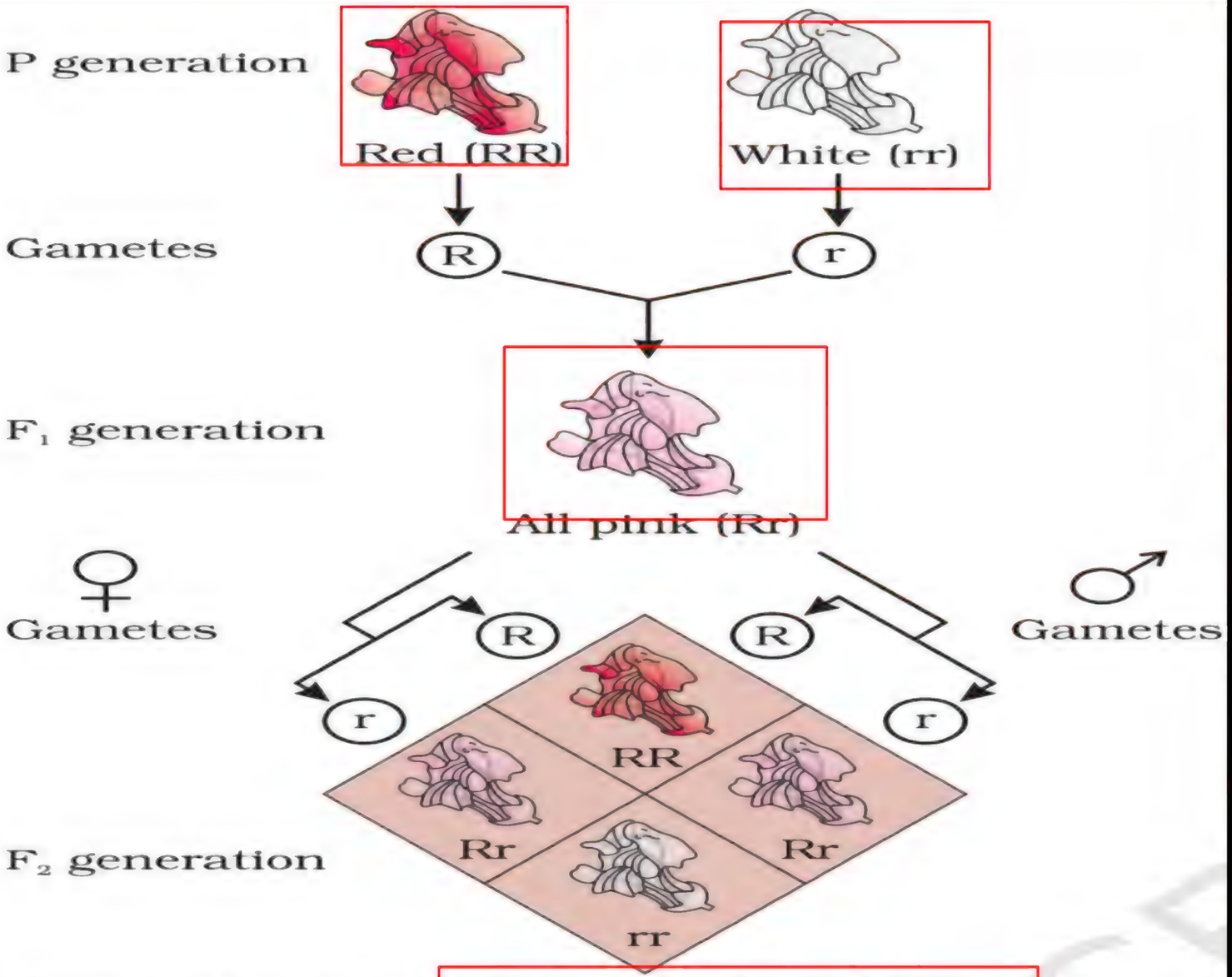
① Cross in which Phenotypic & Genotypic same

(a) incomplete dominance (b) test cross ✓ (c) Both

② Cross in which phenotype & Genotype same

(Deviation of mendel) ✓ incomplete dominance

(b) test cross (c) Both



Phenotypic ratio : red : pink : white
1 : 2 : 1

Genotypic ratio : RR : Rr : rr
1 : 2 : 1

Co dominance

def – Both Allele/Factor of one character is Dominant X
– Both allele of one character Express
F_1 Generation – Express traits of Both Parents

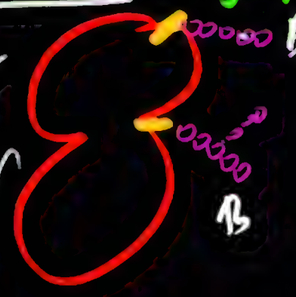
Example → AB Blood Group in ABO Blood Group type

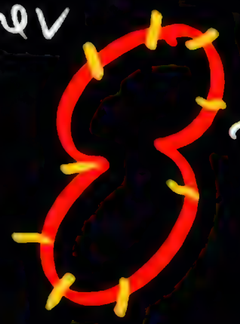
Blood Group type present on Tissue & Blood cells

ABO Blood Group gene → Gene I (name) → three Allele → I^A → Form Sugar polymer on RBC
I^B → Form Sugar polymer on RBC
i → no sugar polymer

(out of three Allele in Human → Any two

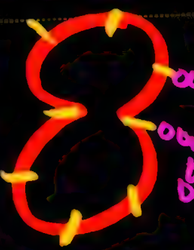
When I^A & I^B together in Human → Co-Dominance





no sugar polymer

(Antigen-A)
Due to I^A
Sugar polymer



Due to I^B
Sugar polymer

I^A Dominant over i

I^B Dominant over i

I^A & I^B → Among → Co dominance
together

ABO Blood Group → Example of)

① Dominance
$I^A i$, $I^B i$

② Co dominant
$I^A I^B$

③ Multiple alleles

$I_A = I_B > i$

Phenotype	Blood Group	Antigen	Genotype	
	A	A	$I^A I^A$	1
			$I^A i$	2
	B	B	$I^B I^B$	3
			$I^B i$	4
	AB	A & B	$I^A I^B$	5
	O	No Antigen	ii	6

• Blood Group - Example of →

total phenotype — 4

total Genotype — 6

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DOPA -03

Q1 law of segregation Applicable to all Except
(a) Diploid (b) Monohybrid (c) Dihybrid (d) Haploid

Q2 Which pure For Any trait
(a) Gamete (b) Zygote (c) Hybrid (d) all

Q3 F_1 Resemble to any one of the Parent due to
(a) Dominance (b) Segregation (c) incomplete dominance (d) all

Q4 F_2 generation tall is more than dwarf Due to
(a) Co dominance (b) Dominance (c) Segregation (d) all

Q5 TtRr have 50% pollen with (T) gene Due to
(a) law of Dominance (b) law of segregation (c) Both (d) none

Q6 Not show Segregation
(a) TR (b) TtRr (c) Tt (d) TTRR

Q7 Not show Segregation (a) Homozygous (b) Monohybrid (c) Heterozygous (d) Gamete

Q8 Pink Flower number 200 in F_2 generation in cross B/w Red & white then no. of white in F_2 generation
(a) 100 (b) 200 (c) 400 (d) none

Q9 In a cross B/w Pink with white Flower give
(a) 50% Pink (b) 50% white (c) all Pink (d) all white

Q10 AB Blood Group child not have ___ Blood Group of mother
(a) B (b) A (c) AB (d) O

Q11 Blood Group control By ___ alleles in individual → (a) two (b) three (c) One (d) all

Q12 Blood Group control By ___ alleles in population → (a) two (b) three (c) Four (d) all

MANTHAN NEET 2025(1.0१२.0)

SANKALP NEET VEDANTU

principle of inheritance

lecture-06

Botany

TARUN SIR

Topics

introduction-gene,allele ,chromosome ,haploid,diploid

Mendelian principle- hybridisation experiment,result,law and cross

Gene interaction- incomplete dominance,co-dominance and muliple allele, polygenic inhritance

DOPA Prime-1

Chromosomal theory, linkage and sex determination

Dopa prime-2

Mutation,pedigree analysis , genetic disroder

Dopa prime-3

DOPA -03

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(a) law of Dominance (b) law of segregation (c) Both (d) none

Q6 Not show Segregation

(a) TR (b) TtRr (c) Tt (d) TTRR

2n 2n 2n

Red x White

↓

Pink

↓

R : P : W

1 2 1

Q7 Not show Segregation (a) Homozygous (b) Monohybrid (c) Heterozygous (d) Gamete

Q8 Pink Flower number 200 in F_2 generation in cross B/w Red & white then no. of white in F_2 generation

(a) 100 (b) 200 (c) 400 (d) none

1 : 200 : 1

1W Pink 1W

R x W

↓

Pink F_1

F_2 - 2W

Q9 In a cross B/w Pink with white Flower give $Rr \times rr \rightarrow$ Rr - Pink, rr - White

(a) 50% Pink (b) 50% white (c) all Pink (d) all white

Q10 AB Blood Group child not have — Blood Group of mother

(a) B (b) A (c) AB (d) O

ii

↓

AB

Q11 Blood Group control By — alleles in individual → (a) two (b) three (c) One (d) all

Q12 Blood Group control By — alleles in population → (a) two (b) three (c) Four (d) all

Table 4.2: Table Showing the Genetic Basis of Blood Groups in Human Population

Allele from Parent 1	Allele from Parent 2	Genotype of offspring	Blood types of offspring
I^A	I^A	$I^A I^A$	A
I^A	I^B	$I^A I^B$	AB
I^A	i	$I^A i$	A
I^B	I^A	$I^A I^B$	AB
I^B	I^B	$I^B I^B$	B
I^B	i	$I^B i$	B
i	i	$i\,i$	O

4.2.2.2 Co-dominance

Till now we were discussing crosses where the F_1 resembled either of the two parents (dominance) or was in-between (incomplete dominance). But, in the case of co-dominance the F_1 generation resembles both parents. A good example is different types of red blood cells that determine ABO blood grouping in human beings. ABO blood groups are controlled by the gene ***I***. The plasma membrane of the red blood cells has sugar polymers that protrude from its surface and the kind of sugar is controlled by the gene. The gene (***I***) has three alleles I^A, I^B and ***i***. The alleles I^A and I^B produce a slightly different form of the sugar while allele ***i*** does not produce any sugar. Because humans are diploid organisms, each person possesses

gene. The gene (*I*) has three alleles I^A, I^B and *i*. The alleles I^A and I^B produce a slightly different form of the sugar while allele *i* does not produce any sugar. Because humans are diploid organisms, each person possesses any two of the three *I* gene alleles. I^A and I^B are completely dominant over *i*, in other words when I^A and *i* are present only I^A expresses (because *i* does not produce any sugar), and when I^B and *i* are present I^B expresses. But when I^A and I^B are present together they both express their own types of sugars: this is because of co-dominance. Hence red blood cells have both A and B types of sugars. Since there are three different alleles, there are six different combinations of these three alleles that are possible, and therefore, a total of six different genotypes of the human ABO blood types (Table 4.2). *How many phenotypes are possible?*

Multiple allele

Acc. to mendel → 1 Character = 2 allele (contransting)

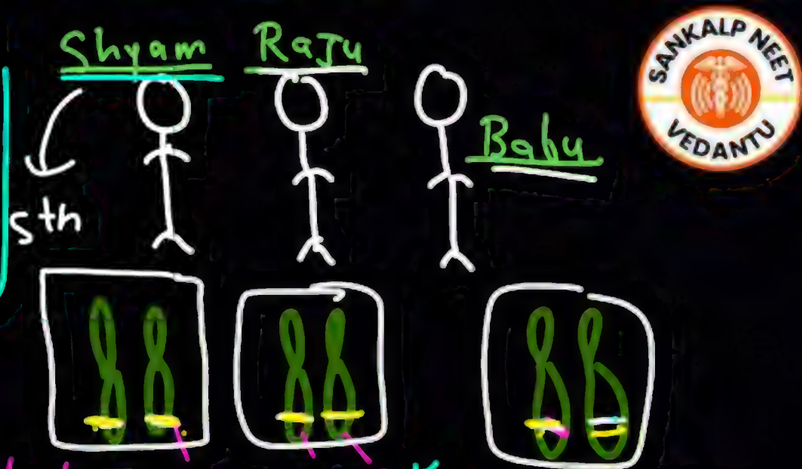
Def → 1 character more than two allele

in one ~~individual~~ Population

Ex- Blood Group (character), in population three allele (I^A, I^B, i)

In one Human (Diploid) ⟶ only two allele out of many

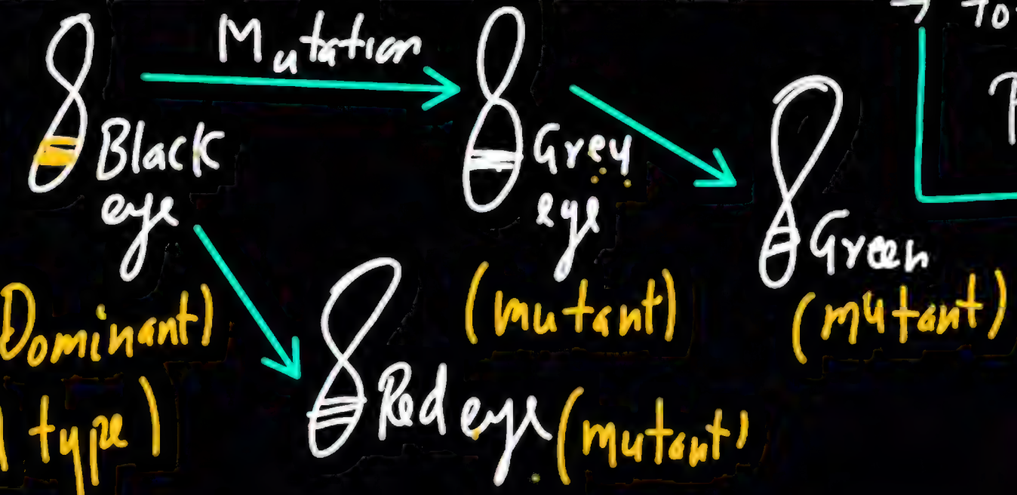
Feature of Multiple → Same → Character ✓, Chromosome number ✓, locus



→ Total Allele in individual ⟶ 2

→ total Allele in Population ⟶ 3 (Black, Blue, Brown

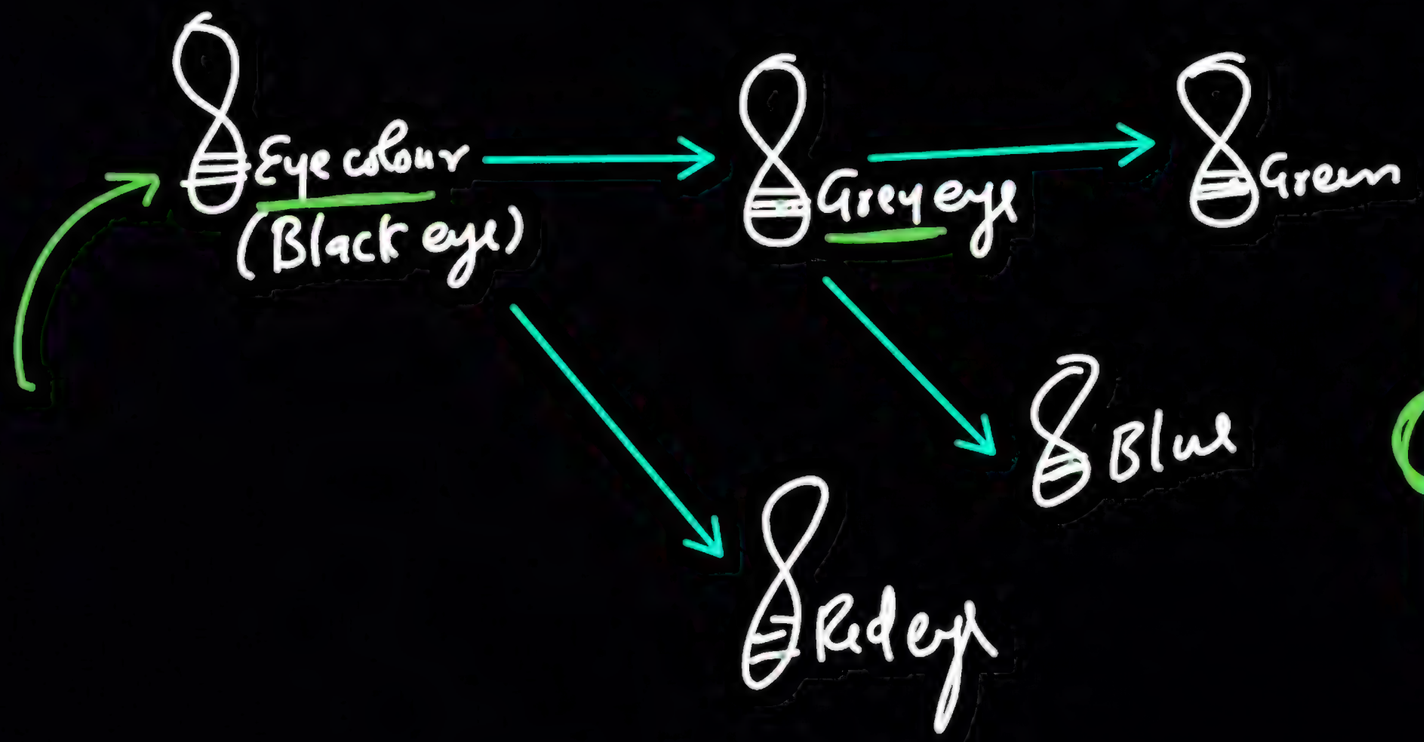
Evolution of Multiple allele →



Mutant allele can be Dominant, Co dominant incomplete dominant Among themself

* Multiple allele → no. of allele in population → possible genotype predict → $\frac{n(n+1)}{2}$

(Blood Group = 3 allele, $n=3$, Genotype = 6)



First allele = Black Allele (Dominant / wild type)

(Grey eye, Green eye, Blue eye, Red eye) — 4 allele - Mutant

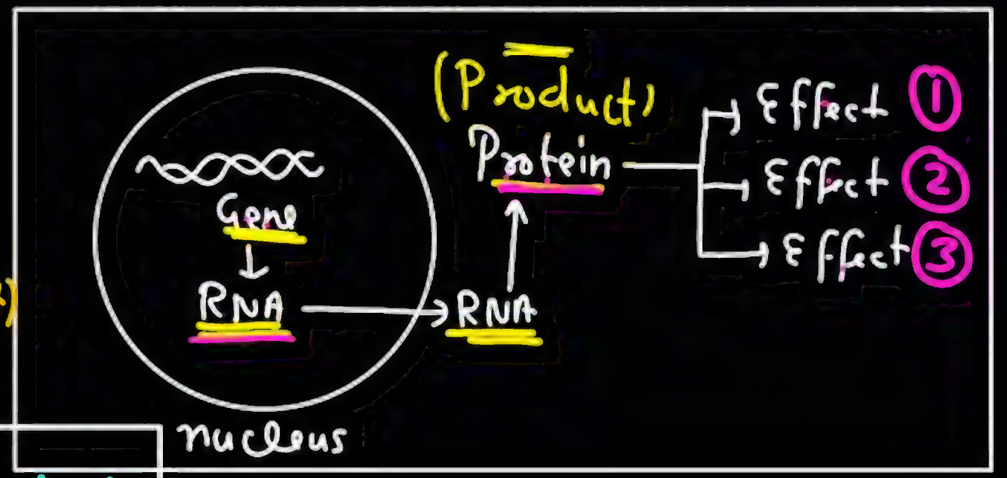
Do you realise that the example of ABO blood grouping also provides a good example of **multiple alleles?** Here you can see that there are more than two, i.e., three alleles, governing the same character. Since in an individual only two alleles can be present, multiple alleles can be found only when population studies are made.

pleiotropy

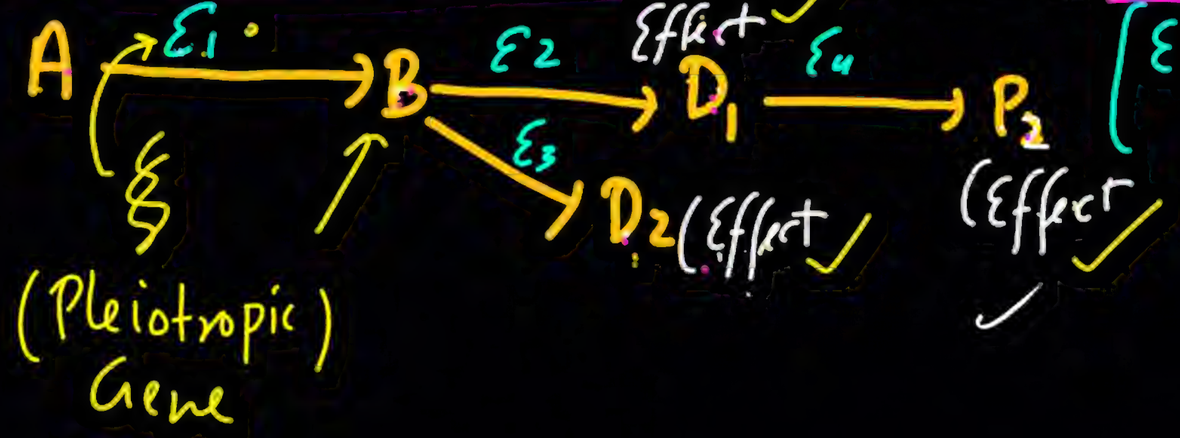
Acc to Mendel → 1 Factor → control one trait

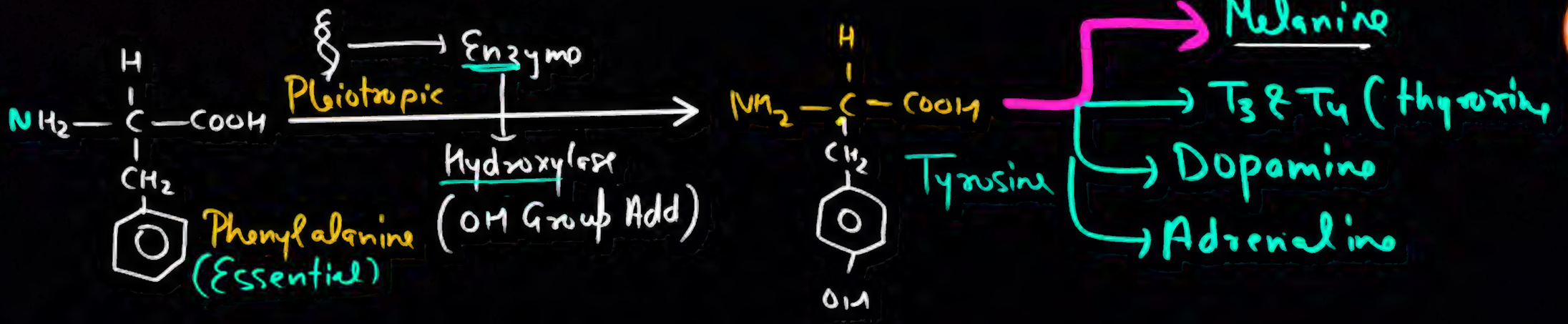
Pleiotropy → 1 Gene → Produce one protein (Gene product) → many effect

1 Factor/Gene → control more than one train



Example → In metabolic pathways → Gene control initial Enzymes are pleiotropic gene





* Pleiotropic Gene → produce Hydroxylase → Convert Phe into tyr
  → control many trait

* Disease → Gene For Hydroxylase mutation occured → Gene impact → Enzyme Hydroxylase Absent → many symptoms
  - dec. Skin & Hair Pigment
  - Phenylalanine Excess → Convert into phenylpyruvate → mental Retardation occur
  - Come in urine

Table 4.2: Table Showing the Genetic Basis

Starch Synthesis Gene — Another Example of pleiotropy

Starch ⟶ Grain Form Synthesise occur ⟶ Gene B — involve Strach Grain Synthesis

(incomplete dominance)

Genotype	Starch grain	Seed shape (Dominance)
BB	(large)	Round
Bb	(intermediate)	Round
bb	(Small Starch grain)	Wrinkled

Gene B (Pleiotropic Gene)

↓

Two trait control in

(a) Seed shape

(b) Starch grain

BB × bb

Round — Wrinkled

Round ↓ Intermediate Starch Grain

↓ Selfing

	B	b
B		
b		

Seed shape → Round, wrinkled → Dominance (3:1)

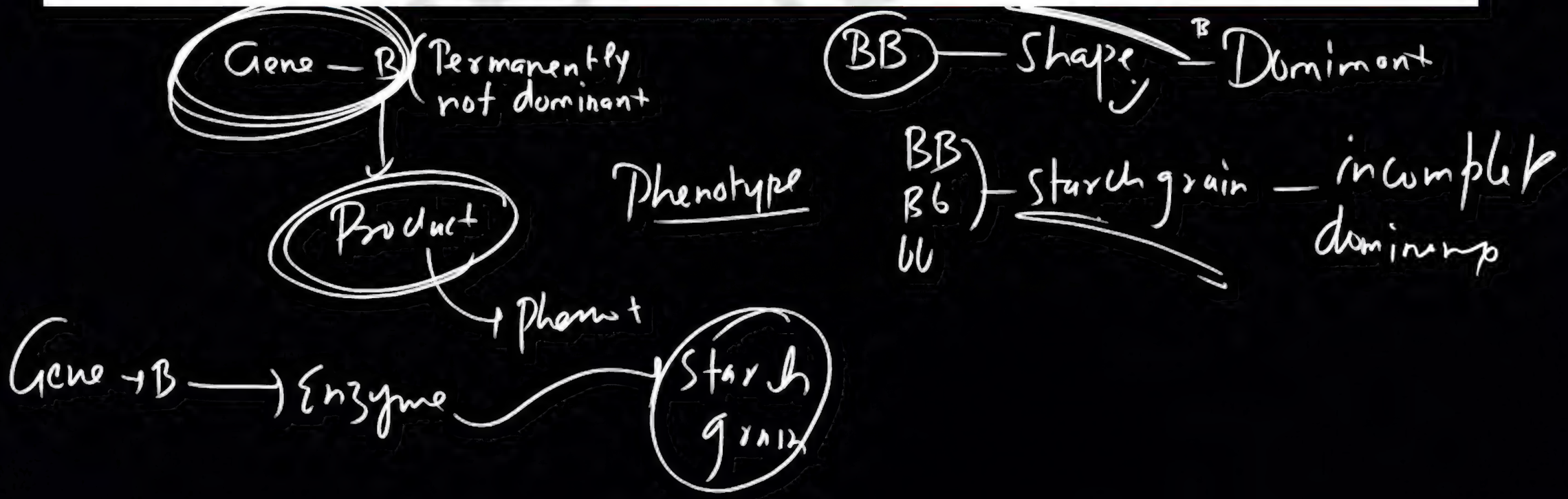
Starch grain size → large, intermediate, small (1:2:1) (incomplete dominance)

4.5 Pleiotropy

We have so far seen the effect of a gene on a single phenotype or trait. There are however instances where a single gene can exhibit multiple phenotypic expression. Such a gene is called a pleiotropic gene. The underlying mechanism of pleiotropy in most cases is the effect of a gene on metabolic pathways which contribute towards different phenotypes. An example of this is the disease phenylketonuria, which occurs in humans. The disease is caused by mutation in the gene that codes for the enzyme phenyl alanine hydroxylase (single gene mutation). This manifests itself through phenotypic expression characterised by mental retardation and a reduction in hair and skin pigmentation.

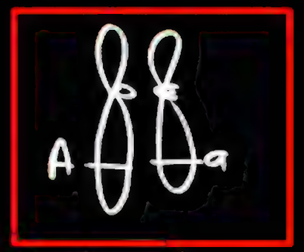
Occasionally, a single gene product may produce more than one effect. For example starch synthesis in pea seeds is controlled by one gene. It has two alleles (**B** and **b**). Starch is synthesised effectively by **BB** homozygotes and therefore, large starch grains are produced. In contrast, **bb** homozygotes have lesser efficiency in starch synthesis and produce smaller starch grains. After maturation of the seeds, **BB** seeds are round and the **bb** seeds are wrinkled. Heterozygotes produce round seeds, and so **B** seems to be the dominant allele. But, the starch grains produced are of intermediate size in **Bb** seeds. So if starch grain size is considered as the phenotype, then from this angle, the alleles show incomplete dominance.

Therefore, dominance is not an autonomous feature of a gene or the product that it has information for. It depends as much on the gene product and the production of a particular phenotype from this product as it does on the particular phenotype that we choose to examine, in case more than one phenotype is influenced by the same gene.



Why Some allele is Dominant

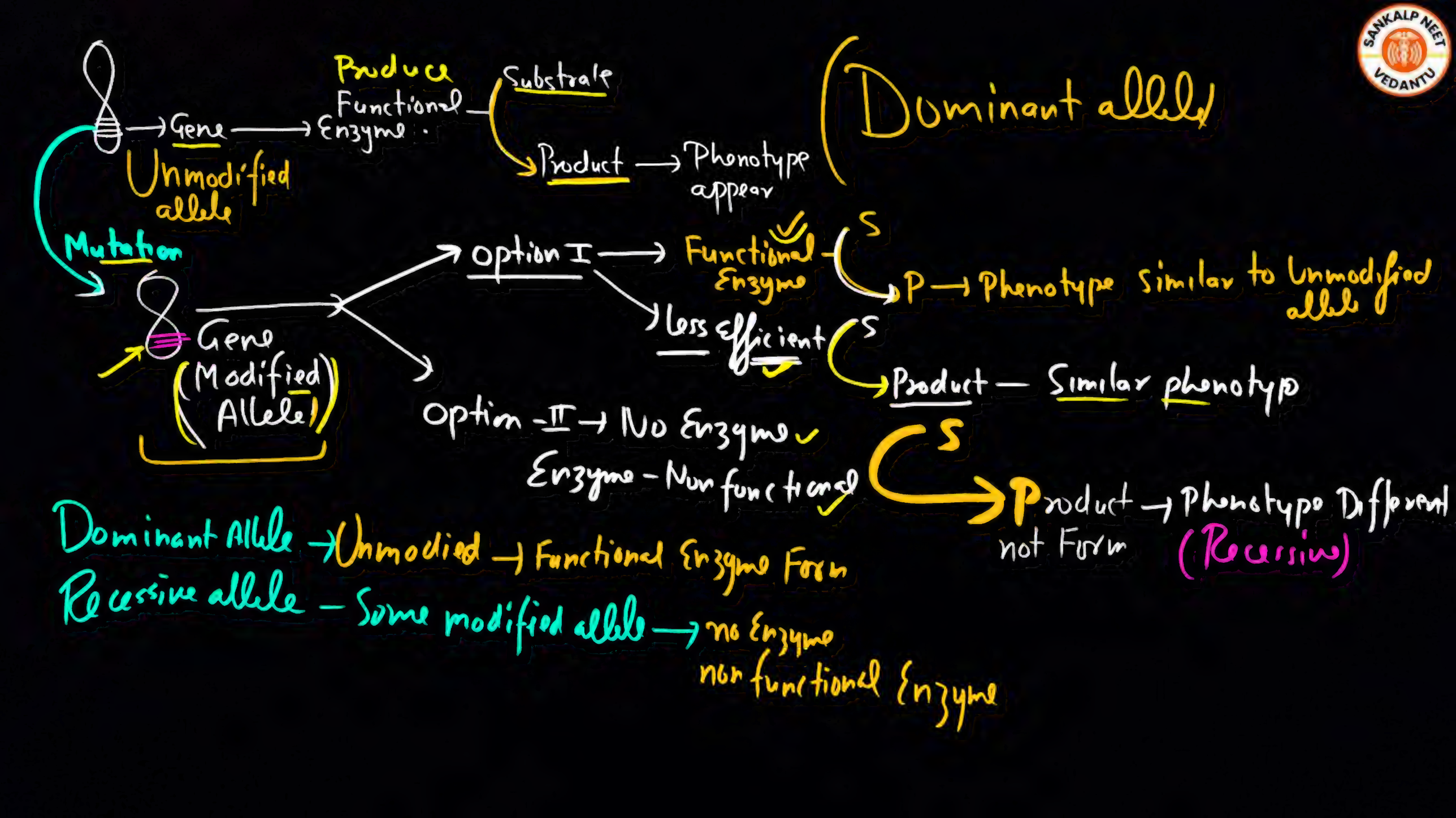
→ In Any Human → 1 character → two allele → gt can be same → Homozygous
→ gt can be Different → Heterozygous



→ Gene control trait → Gene produce Enzyme, that Enzyme convert Substrate into Product → Particular phenotype appear

Gene → Enzyme (Functional)

Substrate (S) + Enzyme → Product (P) → Give phenotype


Gene → Enzyme
Produce Functional Enzyme
Substrate
Product → Phenotype appear
Unmodified allele
Dominant allele
Mutation
Gene (Modified Allele)
option I → Functional Enzyme
S
P → Phenotype Similar to Unmodified allele
Less efficient
S
Product — Similar phenotyp
option -II → No Enzyme
Enzyme - Non functional
S
Product → Phenotype Different
not Form
(Recessive)
Dominant Allele → Unmodied → Functional Enzyme Form
Recessive allele - Some modified allele → no Enzyme
non functional Enzyme

Q Modified allele all Except

(a) Mutant (b) Can be Recessive (c) Can Produce Enzyme Functional (d) Dominant

Q Recessive allele is all Except

(a) Modified (b) Produce less efficient Enzyme (c) Produce No Enzyme (d) Mutant

pink : white
2 : 1

Rr : rr
2 : 1

monohybrid cross in Snapdragon, where le is incompletely over the other allele

distinguish **Rr** as pink from **RR** (red) and **rr** (white) .

Explanation of the concept of dominance: What exactly is dominance? Why are some alleles dominant and some recessive? To tackle these questions, we must understand what a gene does. Every gene, as you know by now, contains the information to express a particular trait. In a diploid organism, there are two copies of each gene, i.e., as a pair of alleles. Now, these two alleles need not always be identical, as in a heterozygote. One of them may be different due to some changes that it has undergone (about which you will read further on, and in the next chapter) which modifies the information that particular allele contains.

Let's take an example of a gene that contains the information for producing an enzyme. Now there are two copies of this gene, the two allelic forms. Let us assume (as is more common) that the normal allele produces the normal enzyme that is needed for the transformation of a substrate S. Theoretically, the modified allele could be responsible for production of –

(i) the normal/less efficient enzyme, or
(ii) a non-functional enzyme, or
(iii) no enzyme at all

In the first case, the modified allele is equivalent to the unmodified allele, i.e., it will produce the same phenotype/trait, i.e., result in the transformation of substrate S. Such equivalent allele pairs are very common. But, if the allele produces a non-functional enzyme or no enzyme, the phenotype may be effected. The phenotype/trait will only be dependent on the functioning of the unmodified allele. The unmodified (functioning) allele, which represents the original phenotype is the dominant allele and the modified allele is generally the recessive allele. Hence, in the example above the recessive trait is seen due to non-functional enzyme or because no enzyme is produced.

MANTHAN NEET 2025(1.0 १२.0)

SANKALP NEET VEDANTU

principle of inheritance

lecture-07

Botany

TARUN SIR

Topics

introduction-gene,allele ,chromosome ,haploid,diploid

Mendelian principle- hybridisation experiment,result,law and cross

Gene interaction- incomplete dominance,co-dominance and muliple allele, polygenic inhritance

DOPA prime-1

Chromosomal theory, linkage and sex determination

Dopa prime-2

Mutation,pedigree analysis , genetic disroder

Dopa prime-3

Law of independent assortment

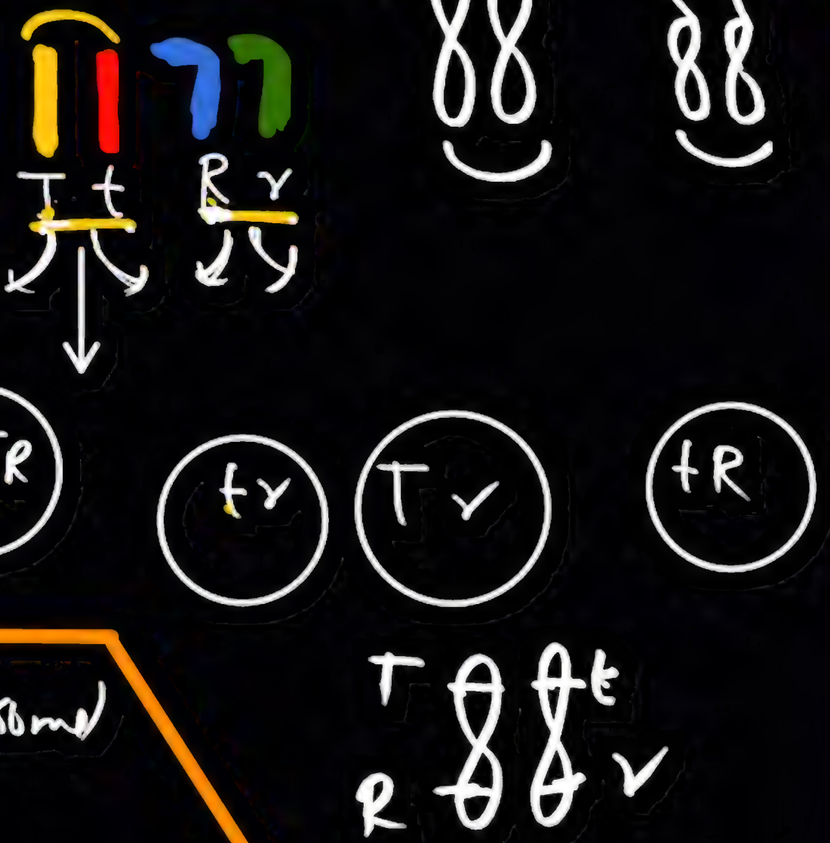
→ Segregation of one pair of Factor not depend on Segregation of other Pair

→ Due to which new combination Form

This law is valid when → T & R - Different Chromosome

→ Exception of this law — Linkage (T & R on same chromosome)

→ At the time of Mendel's work → (Chromosome was not Discovered)



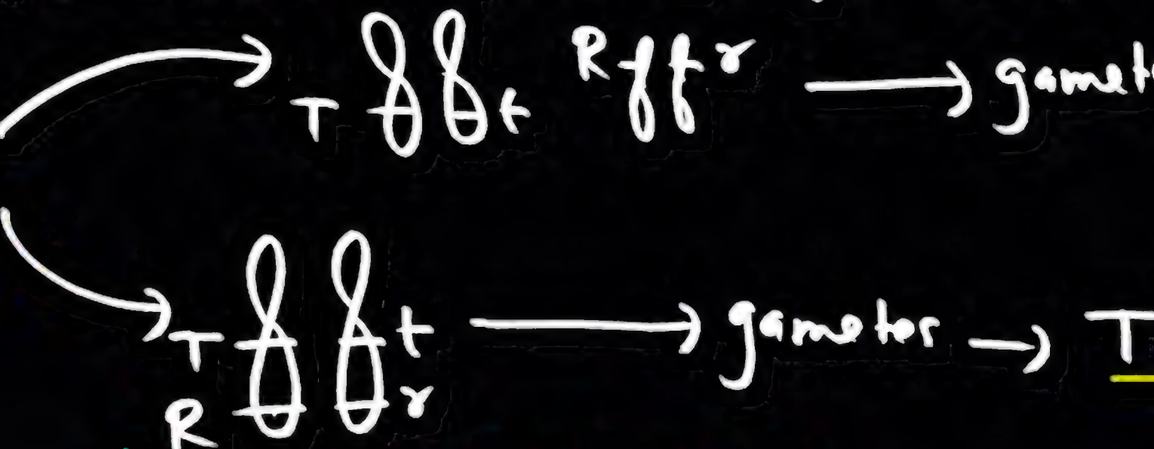
Explanation of independent assortment

(Tt) → Dominance ✓
→ Segregation ✓
→ Independent Assortment ✗

(a) Minimum Dihybrid cross Require

(b) Due to independent assortment – Different type of gametes Form

Example → TtRr (Genotype)



Independent assortment maximum type of gametes Form

(linkage → dec. type of gametes

Q TtRr gametes – (a) Four (b) two (c) one (d) none

Q TtRr Form only two type gamete – (a) independent assortment (b) linkage

Q TtRrYy Form ___ no. of gamete → TRY – Same chromosome

(a) One (b) two (c) Eight

4.3.1 Law of Independent Assortment

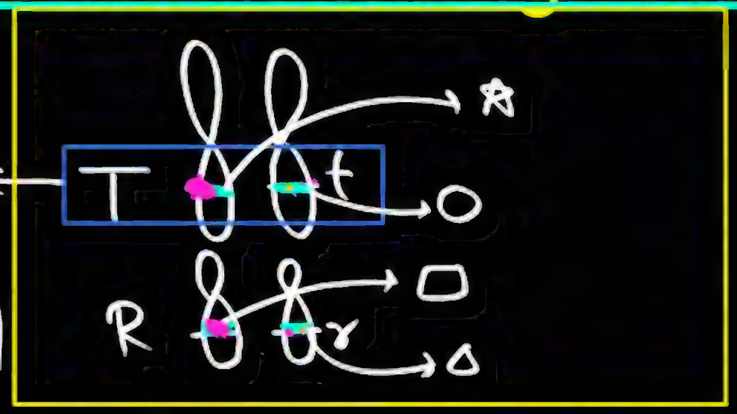
In the dihybrid cross (Figure 4.7), the phenotypes round, yellow; wrinkled, yellow; round, green and wrinkled, green appeared in the ratio 9:3:3:1. Such a ratio was observed for several pairs of characters that Mendel studied.

The ratio of 9:3:3:1 can be derived as a combination series of 3 yellow: 1 green, with 3 round : 1 wrinkled. This derivation can be written as follows:

(3 Round : 1 Wrinkled) (3 Yellow : 1 Green) = 9 Round, Yellow : 3 Wrinkled, Yellow: 3 Round, Green : 1 Wrinkled, Green

Based upon such observations on **dihybrid crosses** (crosses between plants differing in two traits) Mendel proposed a second set of generalisations that we call Mendel's Law of Independent Assortment. The law states that 'when two pairs of traits are combined in a hybrid, segregation of one pair of characters is independent of the other pair of characters'.

Gene interaction of two gene locus



Single gene locus

Interaction B/w product of T & t — Ex

(a) Dominance
(b) Co-dominance ✓
(c) Incomplete dominance ✓
(d) Multiple allele ✓
(e) Pleiotropy ✓

} Acc. to Mendelism

} Deviation of Mendelism

Aa Bb X Aa Bb

Interaction B/w Allele of two Different locus

(a) Independent assortment → Two locus not interact

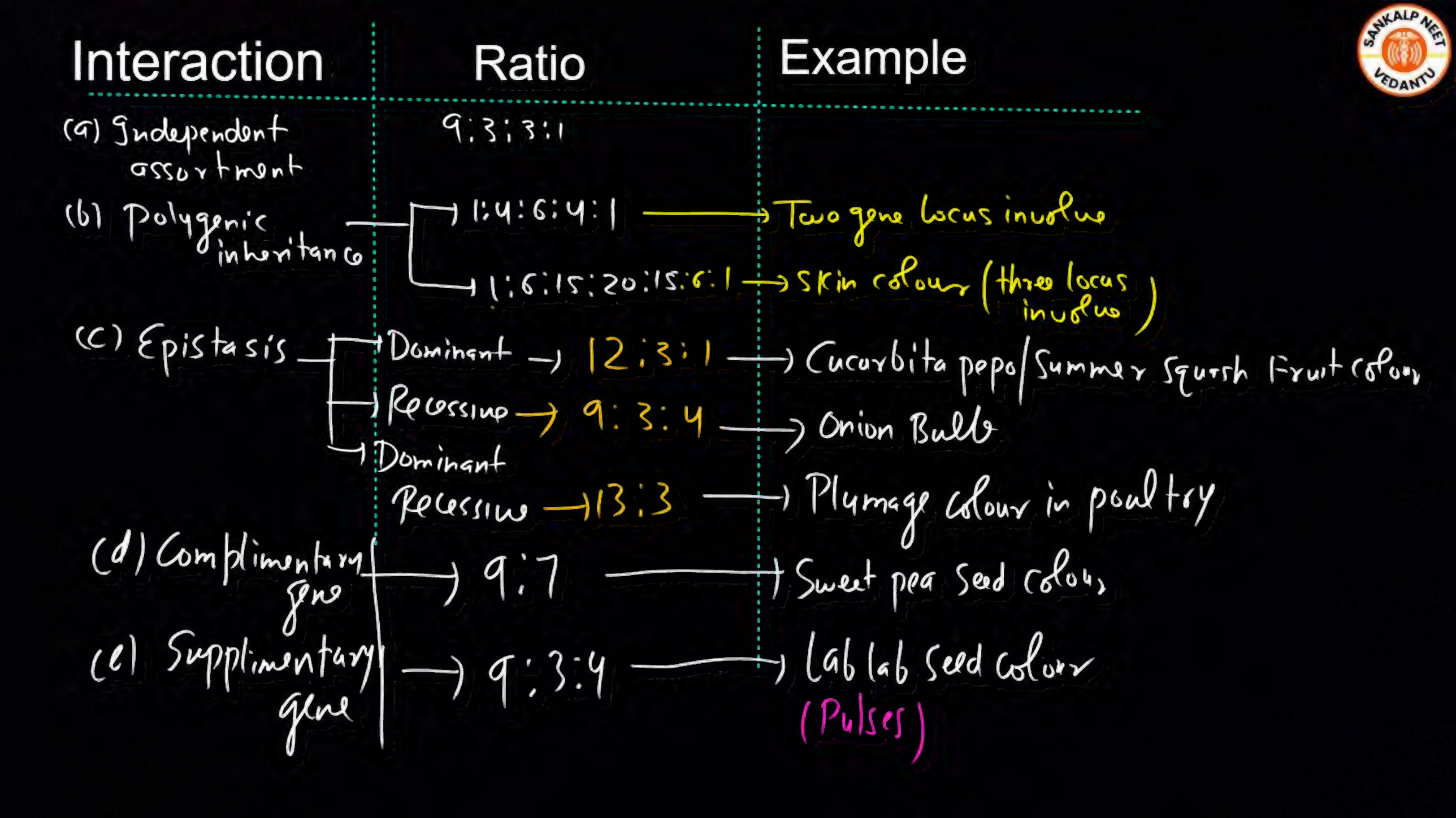
F_2 → Phenotypic Ratio → 9:3:3:1 ∋ Phenotypic = 4

(Result is due to Multiplication of Result of Monohybrid cross)

(b) Polygenic inheritance →
(c) Epistasis
- Dominant
- Recessive →
- Dominant-Recessive →

(d) Complimentary gene
(e) Supplimentary

} Deviation is Mendelism


Interaction
Ratio
Example
(a) Independent assortment
9:3:3:1
(b) Polygenic inheritance
1:4:6:4:1
Two gene locus involve
1:6:15:20:15:6:1
Skin colour (three locus involve)
(c) Epistasis
Dominant
12:3:1
Cucurbita pepo/Summer squash Fruit colour
Recessive
9:3:4
Onion Bulb
Dominant
Recessive
13:3
Plumage colour in poultry
(d) Complimentary gene
9:7
Sweet pea Seed colour
(e) Supplimentary gene
9:3:4
Lab lab Seed colour
(Pulses)

Polygenic Inheritance

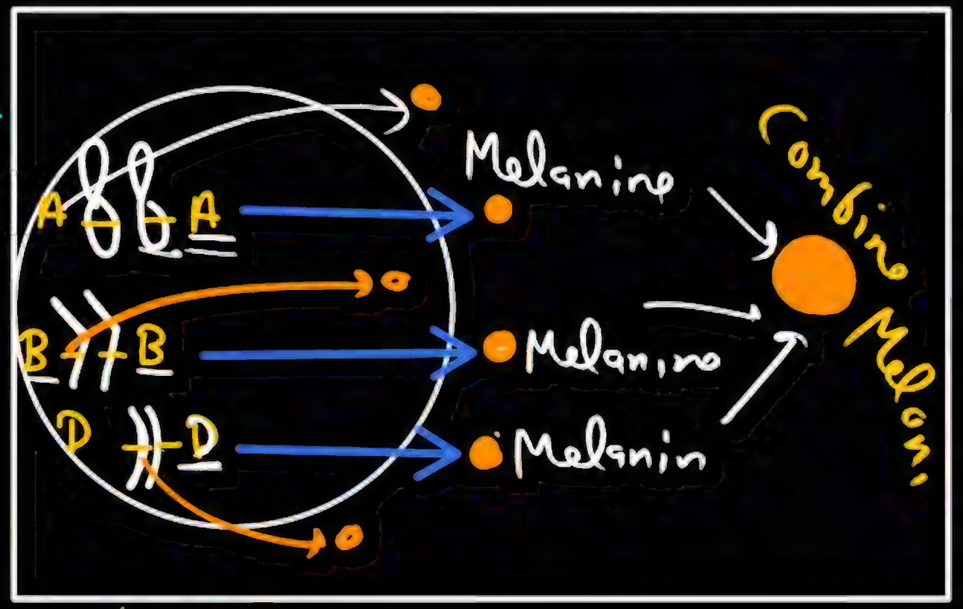
* Acc. to Mendel → Character → only two contrasting trait (Tall & Dwarf)

* In nature → Many Such character – Range of trait
  Example – Skin colour, Human height
  Human IQ

Skin colour → control More than one locus in Human (three locus – Six allele control)

Dominant Allele → Contribute trait → Contribution Add –

Skin colour → three locus control | Six allele
Dominant allele – melanin
Recessive Allele – no melanine



$\overset{1}{A}\overset{2}{A}bbcc$
$AaBbcc$
$1 \quad 2$
} Same skin colour

AABBCC – Darkest

aabbcc → White

Genotype + Environment = Phenotype

skin colour phonotype → Phenotype depend on no of Dominant allele

Phenotype 2n+1

Skin colour – 3 locus

1. aabbcc – white – Zero Dominant (Albino-white)
2. Aabbcc, aaBbcc, aabbCc → 1 Dominant
3. AaBbcc, AAbbcc, Aabbcc, aaBBbb → 2 Dominant
4. AaBbCc, AABbcc, AaBBcc → 3 Dominant (Mulato)
5. AABBcc, aaBBCC → 4 Dominant
6. AABBCc → 5 Dominant
7. AABBCC → 6 Dominant (Black)

AABBCC (Black) × aabbcc (white)

AaBbCc × AaBbCc (8 gamete) × 8 gamete

↓ selfing

64 Box

1 : 6 : 15 : 20 : 15 : 6 : 1

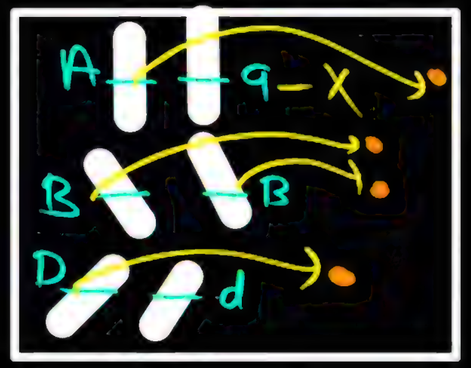
Phenotypic Ratio →

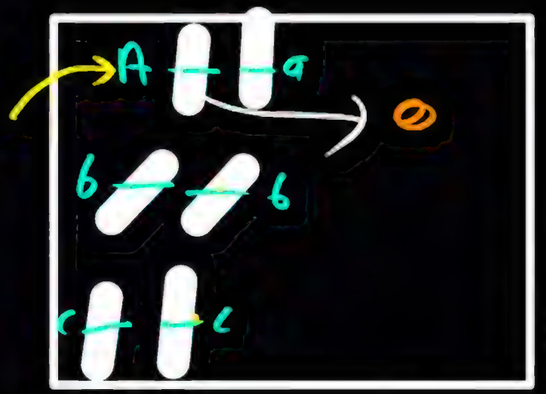
Phenotype = 7

aabbcc ... AABBCC

Two locus → Dominant allele – 4 (max) → Phenotype = 5 ✓

Four locus → Dominant allele → 8 (Max) → Phenotype → 9





aabb cc →] 1

A a bb cc
aa B b cc
aa bb C c] 6

AA bb cc
A a B b cc
A a bb C c] 15

aa BB

0 1 2 3 4

aa bb cc →

A a b b c c → ●

A A bb cc → ● ●

Qualitative

Acc. to Mendel → TT → Tall
Tt → Tall
} Phenotype Exact same

But number of Dominant allele

TtRr - Tall Round
TTRR - Tall Round
} Phenotype Same

Qualitative trait one or two Dominant of Same locus → Same phenotype

Q BB & Bb Different Phenoty inheritance

(a) Qualitative (b) Quantitative

Quantitative

Aa → one Dominant
AA → two Dominant
} not have Same phenotype

→ number of Dominant allele matters

→ Polygenic inheritance is an Example of Quantitative inheritance

4.4 Polygenic Inheritance

Gradient →

Mendel's studies mainly described those traits that have distinct alternate forms such as flower colour which are either purple or white. But if you look around you will find that there are many traits which are not so distinct in their occurrence and are spread across a gradient. For example, in humans we don't just have tall or short people as two distinct alternatives but a whole range of possible heights. Such traits are generally controlled by three or more genes and are thus called as polygenic traits. Besides the involvement of multiple genes polygenic inheritance also takes into account the influence of environment. Human skin colour is another classic example for this. In a polygenic trait the phenotype reflects the contribution of each allele, i.e., the effect of each allele is additive. To understand this better let us assume that three genes A, B, C control skin colour in human with the dominant forms A, B and C responsible for dark skin colour and the recessive forms a, b and c for light skin colour. The genotype with all the dominant alleles (AABBCC) will have the darkest skin colour and that with all the recessive alleles (aabbcc) will have the lightest skin colour. As expected the genotype with three dominant alleles and three recessive alleles will have an intermediate skin colour. In this manner the number of each type of alleles in the genotype would determine the darkness or lightness of the skin in an individual.

DUPA

Q1 Skin colour in Human is an Example of
(a) Qualitative inheritance (b) Multiple allele (c) Quantitative inheritance (d) all

Q2 Range or Gradient of trait is visible due to
(a) Mendelian trait (b) Polygenic (c) Multiple allele (d) all

Q3 In skin colour cross B/w AaBbCc with same genotype Give ____ phenotype
(a) 7 (b) 9 (c) 2 (d) 5

Q4 which not involve Single gene locus
(a) Polygenic inheritance (b) Segregation (c) Dominance (d) all

Q5 AaBbcc have same skin colour to Genotype
(a) Aabbcc (b) AABBcc (c) AABBCC (d) aa BBcc

Q6 For one character → one locus → three allele in population
(a) Polygenic (b) Multiple allele (c) Co-dominance

Q7 Phenotype in skin colour
(a) Range (b) Countinuous variation (c) depend on Environment (d) all

Q8 Independent assortment will give _____ gamete From AaBbCc
(a) two (b) Eight (c) Four (d) Five

Q9 If AaBbCcDd give two gamete then _____ Absent
(a) Segregation (b) Dominance (c) independent assortment (d) all

Q10 Mendel not Able to Discover
(a) linkage (b) incomplete dominance (c) Polygenic inheritance (d) all

Q11 Mark incorrect
(a) one locus → control two trait – Pleiotropy
(b) Two locus → one individual → Polygenic
(c) One gamete → only one allele – Multiple allele
(d) One gamete → three allele of one character → Multiple allele

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SANKALP NEET VEDANTU

principle of inheritance

lecture- 08

Botany

TARUN SIR

Topics

introduction-gene,allele ,chromosome ,haploid,diploid

Mendelian principle- hybridisation experiment,result,law and cross

Gene interaction- incomplete dominance,co-dominance and muliple allele, polygenic inhritance

DOPA prime-1

Chromosomal theory, linkage and sex determination

Dopa prime-2

Mutation,pedigree analysis , genetic disroder

Dopa prime-3

DUPA

Q1 Skin colour in Human is an Example of
(a) Qualitative inheritance (b) Multiple allele (c) Quantitative inheritance (d) all

Q2 Range or Gradient of trait is visible due to
(a) Mendelian trait (b) Polygenic (c) Multiple allele (d) all

Q3 In skin colour cross B/w AaBbCc with same genotype Give ? — phenotype
4 locus → 9
(a) 7 (b) 9 (c) 2 (d) 5
3 locus → 3×2+1 ⇒ 7

Q4 which not involve Single gene locus
(a) Polygenic inheritance (b) Segregation (c) Dominance (d) all

Q5 AaBbcc have same skin colour to Genotype
(a) Aabbcc (b) AABB cc (c) AABBCC (d) aa BBcc
1 1 2 3 4 2

Q6 For one character → one locus → three allele in population
(a) Polygenic (b) Multiple allele (c) Co-dominance

AaBbcc →
AaBbCc →
aabbcc — 0
AAbbCc — 3
AAbbCC — 4

Q7 Phenotype in Skin colour
(a) Range (b) Countinuous variation (c) depend on Environment (d) all

Q8 Independent assortment will give 8 gamete From AaBbCc
(a) two (b) Eight (c) Four (d) Five

Q9 If AaBbCcDd give two gamete then ____ Absent
(a) Segregation (b) Dominance (c) independent assortment (d) all

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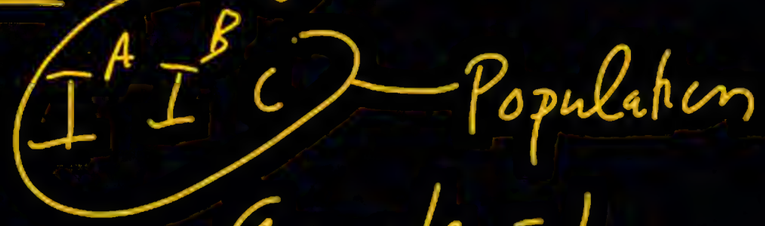
(a) linkage (b) incomplete dominance (c) Polygenic inheritance (d) all

Q11 Mark incorrect
(a) one locus → control two trait – Pleiotropy ✓
(b) Two locus → one individual → Polygenic ✓
(c) One gamete → only one allele – Multiple allele
(d) One gamete → three allele of one character → Multiple allele



Gamete = 1
Zygote

Why mended work was not get Recognition

Mendel Published in — 1865

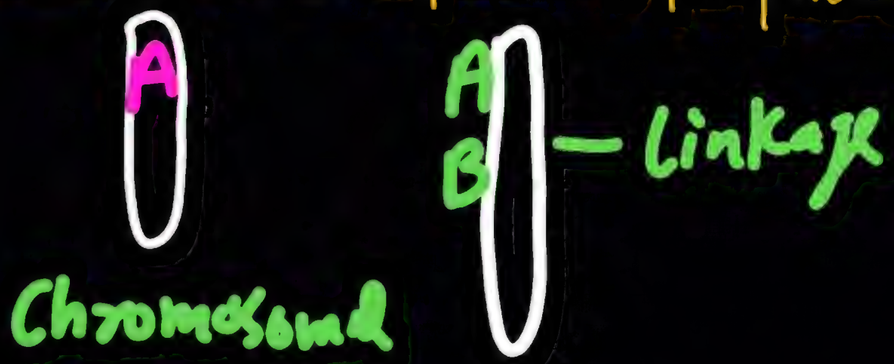
(a) Work → not widely published — not get Recognition

(b) Acc to Mendel → Factor discrete unit - not show Blending
(nature — Countinous variation present

(c) Mendel use → Mathematics to Explain Biological Phenomenon
(Many Scientist of that time → not Accepted)

(d) Mendel → not able to Explain → Physical presence of Factors

*



Chromosomal theory of inheritance

Why this theory — Two parallel development

Chromosome Discovered inside nucleus
↓ (Colour Body)

During Meiosis → (Pair & seperate) in meiosis

1900 → chromosome Behaviour study

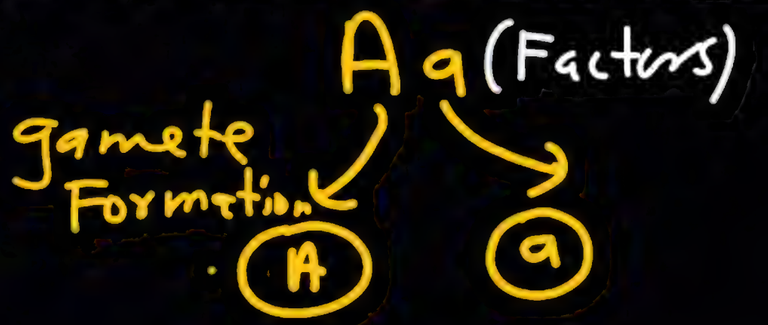
1900
Three scientist — Mendel's work
Rediscovery (Results check)
Carl correns, Erich von Tschermark
Hugo de vries

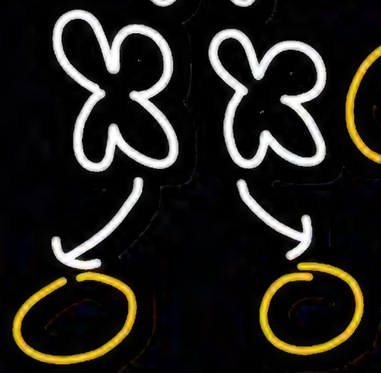
1902 — Sutton & Boveri → Use chromosomal inheritance to Explain Mendel's Law of inheritance

Important points

(a) Chromosome occur in pair ⟶ and Factors occur in pairs

(b) Both chromosome & Factor show Segregation – Seperation → During gamete Formation

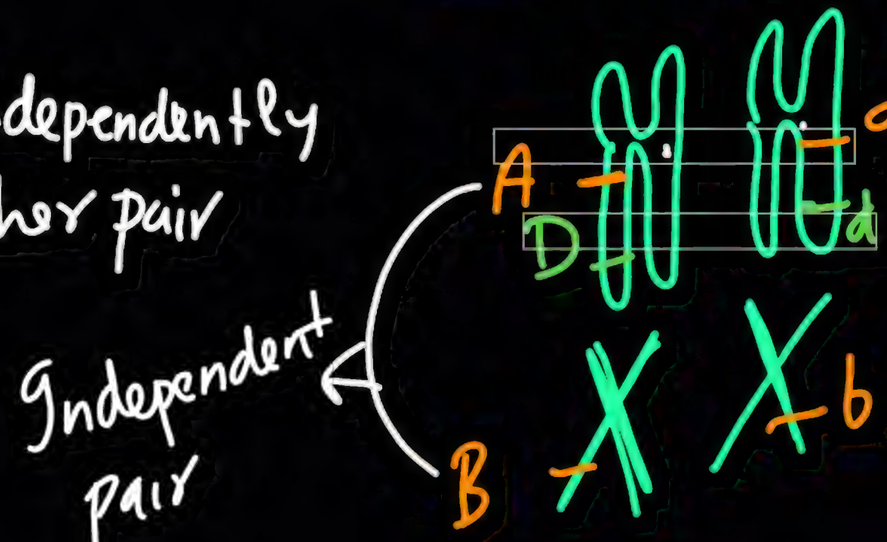




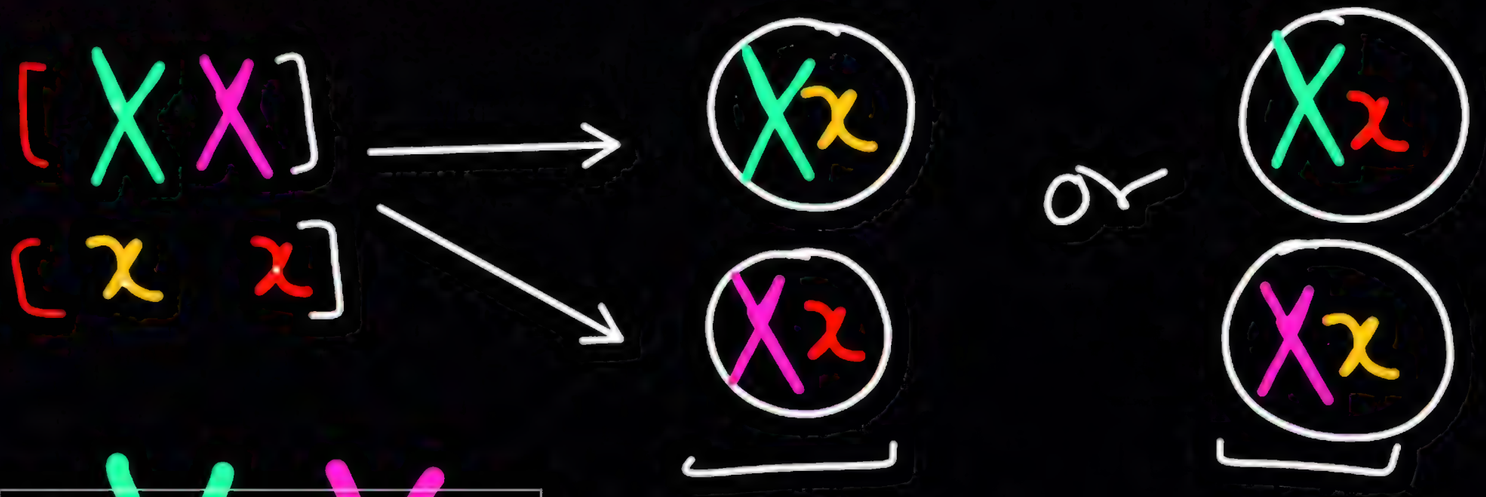
(Segregate → Anaphase I → Meiosis I)

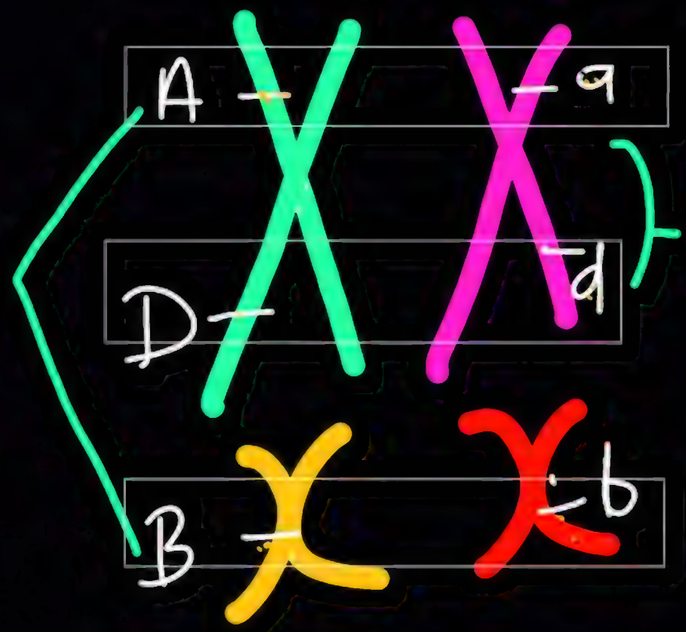
(Responsible For gamete Formation

(c) One pair Segregate independently to other pair



For chromosome dependent pair





dependent

- Chromosome Always segregate independently
- Factors pair → two type → Independent pairs (Independent assortment)
  → dependent pairs (linkage)

Sutton and Boveri ⟶ Pairing & Segregation of Chromosome lead to Pairing & segregation of Factor

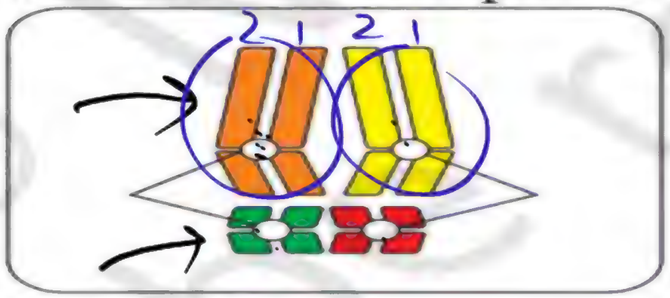
Sutton ⟶ combine all this and postulate Chromosomal theory of inheritance

(1) Chromosomal theory proposed By
(a) Sutton & Boveri (b) Morgan (c) Mendel (d) none

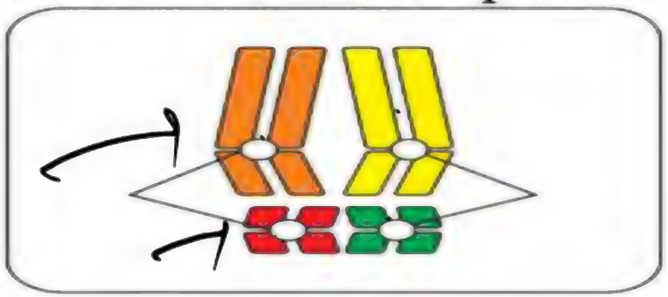
Experimental verification of Chromosomal theory ⟶ T. H Morgan
(Work on Drosophila (Fruit Fly)

Possibility I	Possibility II
One long orange and short green chromosome and long yellow and short red chromosome at the	One long orange and short red chromosome and long yellow and short green chromosome at the

Meiosis I - anaphase

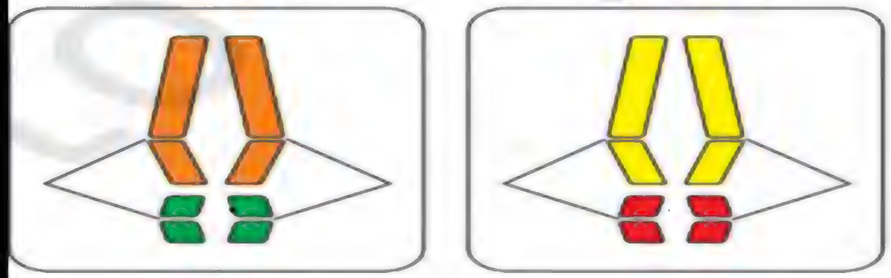


Meiosis I - anaphase



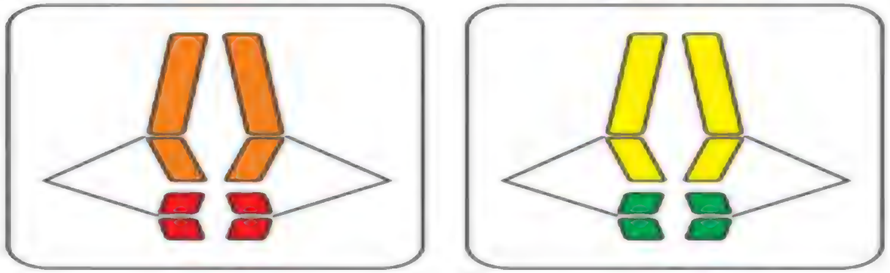
Anaphase I

Meiosis II - anaphase

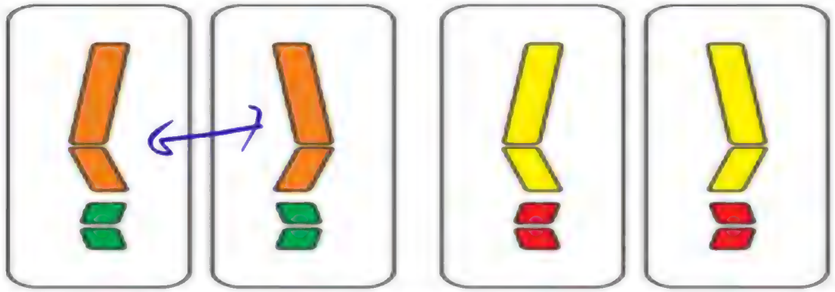


Anaphase II
(Sister chromatid separate)

Meiosis II - anaphase



Germ cells



Germ cells

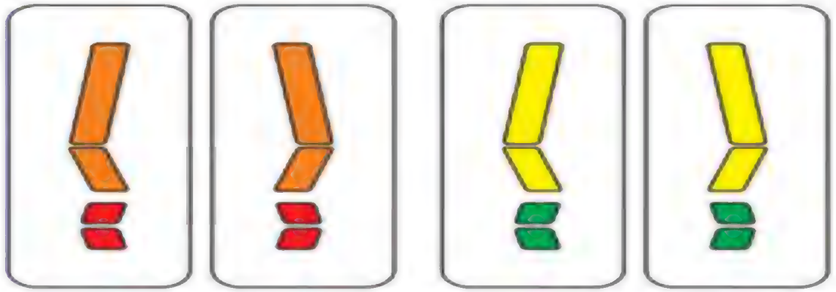


Table 4.3: A Comparison between the Behaviour of Chromosomes and Genes

A	B
Occur in pairs	Occur in pairs
Segregate at the time of gamete formation such that only one of each pair is transmitted to a gamete	Segregate at gamete formation and only one of each pair is transmitted to a gamete
Independent pairs segregate independently of each other	One pair segregates independently of another pair

Can you tell which of these columns A or B represent the chromosome and which represents the gene? How did you decide?

Why drosophila – Selected By Morgan

(a) Can be Grown in Simple synthetic medium in lab

(b) Complete life cycle in – 2 week

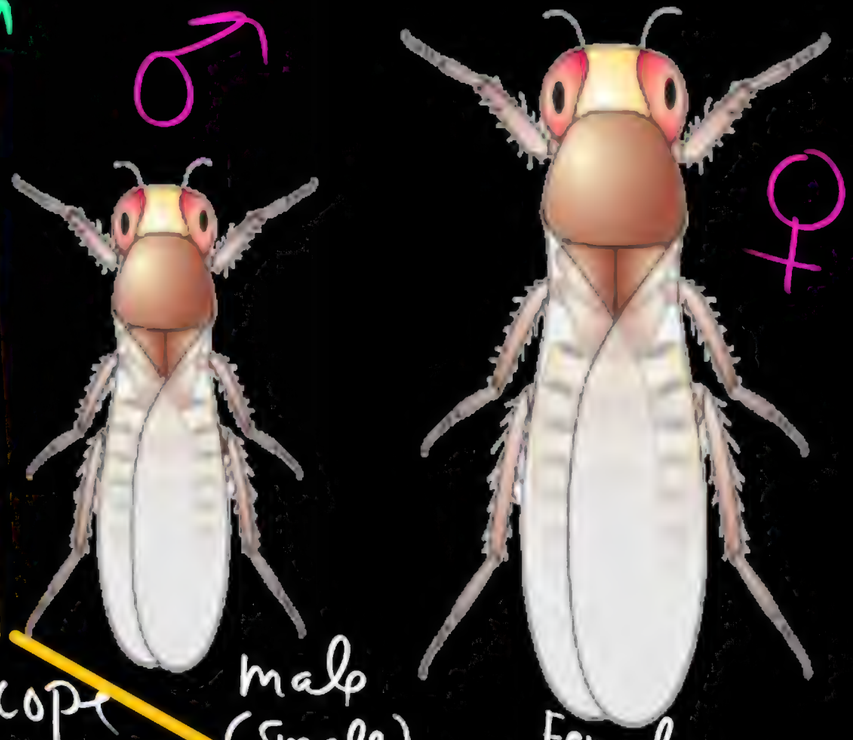
(c) Single mating produce → (large no. of progeny)
(Sample size large)

(d) Clear Distinction in – male & Female

(e) Many characters → Easily seen in low power Microscope

Drosphophila melanogester (Fruit Fly) ⟶ total chromosome ($2n = 8$)

male → XY – Sex chromosome
3 pair / 6 chromosome = Autosome



Female → XX (Sex chromosome)
3 pair / 6 chromosome
⇒ Autosome

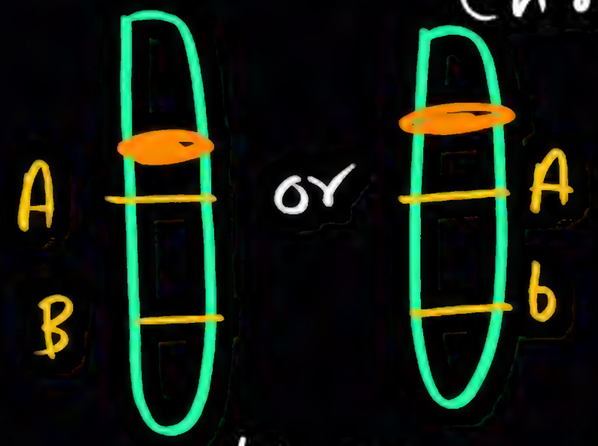
that sexual reproduction produced. Morgan worked with the tiny fruit flies, ***Drosophila melanogaster*** (Figure 4.10), which were found very suitable for such studies. They could be grown on simple synthetic medium in the laboratory. They complete their life cycle in about two weeks and a single mating could produce a large number of progeny flies. Also, there was a clear differentiation of the sexes – the male and female flies are easily distinguishable. Also, it has many types of hereditary variations that can be seen with low power microscopes.

linkage

* Acc. to chromosomal theory ⟶ Factors located on chromosome

Linkage ⟶ Two or More Gene/Factor of Different Characters present on same Chromosome

or Genes are Physically linked



Linkage

} not possible
A & a → of same character

Q Linkage is

(a) One chromosome One Factor

(b) One chromosome two Factor one locus

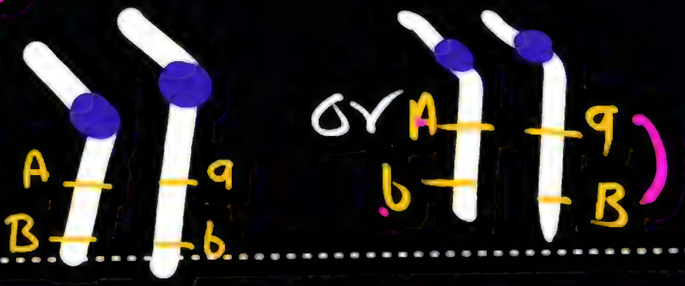
(c) One chromosome two Factor two Locus

(d) all

Linkage -

Explanation :-

- meaning → A & B linked gene ✓
  a & b - linked gene



- Effect of linkage →

I No linkage → AaBb → (genotype)

gametes (Independent assortment)

4 gametes Possible

Maximum possible number

II Linkage → AaBb (genotype)

- A & B linked gene

Linked gene - they tend to Remain together

Remain together - Decrease in Number of gamete

No independent Assortment

Parental and Recombinant

Linkage study → By testcross
→ Normal Dihybrid cross

(Tall Round) TtRr × ttrr (Test cross) (Dwarf wrinkled) — Parents

no linkage

T ‖ t
R ‖ r

↓

P
1. TtRr — Tall Round — Parental
2. Ttrr — tall wrinkled
3. ttRr — Dwarf Round
— Recombinant
4. ttrr — Dwarf Wrinkled → Parental

50% Parental & 50% Recombinant

Linkage →

TtRr × ttrr
Tall Round dwarf wrinkled

T t
R r

↓

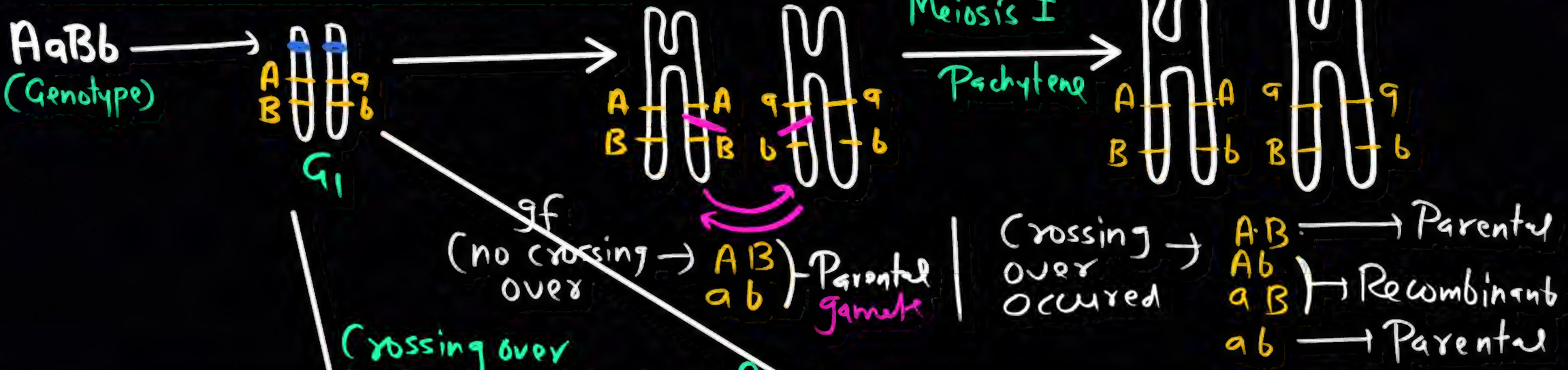
1. TtRr → Tall Round
2. ttrr → dwarf wrinkled

100 Parental

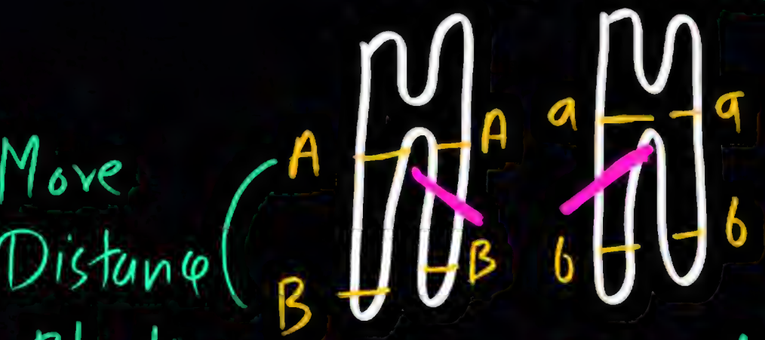
Parental → 100% Recombinants = 0%

* Linkage Increase Parental type and decrease Recombinant
* Independent Assortment – Increase Recombinant

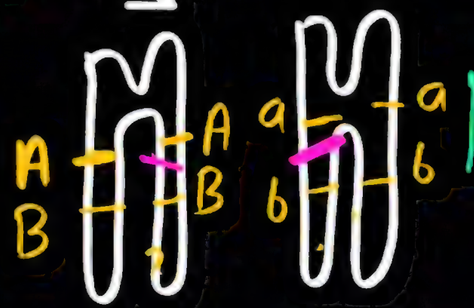
what is crossing over → Crossing over Increase Recombinant



Crossing over Depend on Distance of linked Gene



Move Distance (B/w linked gene) → More Chance of crossing over → more Recombinant



less Distance → less Chance of Crossing over → less Recombinant

DOPA

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(a) Factor occur in pair (b) Factor Segregate (c) Pairing and segregation of chromosome pair & segregate Factor (d) all

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(a) less distance (b) close (c) at more Distance (d) all

MANTHAN NEET 2025(1.0१२.0)

SANKALP NEET VEDANTU

principle of inheritance

lecture- 09

Botany

TARUN SIR

Topics

introduction-gene,allele ,chromosome ,haploid,diploid

Mendelian principle- hybridisation experiment,result,law and cross

Gene interaction- incomplete dominance,co-dominance and muliple allele, polygenic inhritance

Dopa prime-1

Chromosomal theory, linkage and sex determination

Dopa prime-2

Mutation,pedigree analysis , genetic disroder

Dopa prime-3

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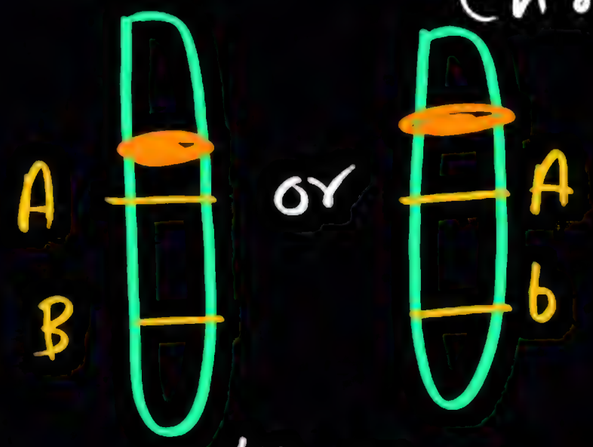
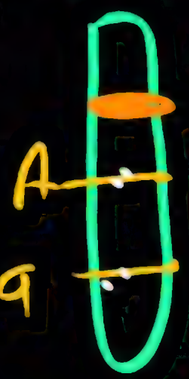


Linkage



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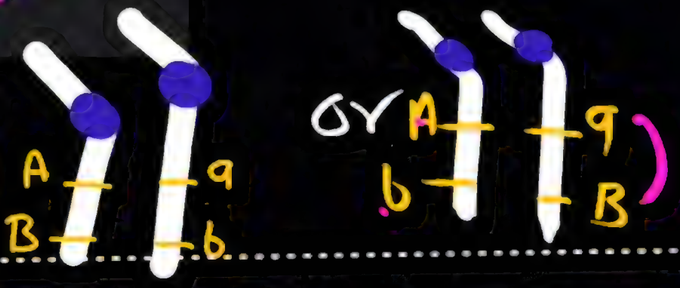

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Linked gene Remain together

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(Tall Round) TtRr × ttrr (Test cross) — Parents
(Dwarf wrinkled)

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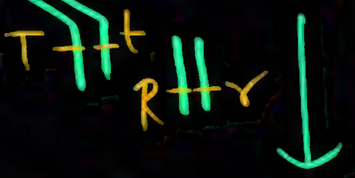

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1. TtRr — Tall Round — Parental
2. Ttrr — tall wrinkled
3. ttRr — Dwarf Round
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50% Parental & 50% Recombinant

Linkage →

TtRr × ttrr
Tall Round — dwarf wrinkled

1. TtRr → Tall Round
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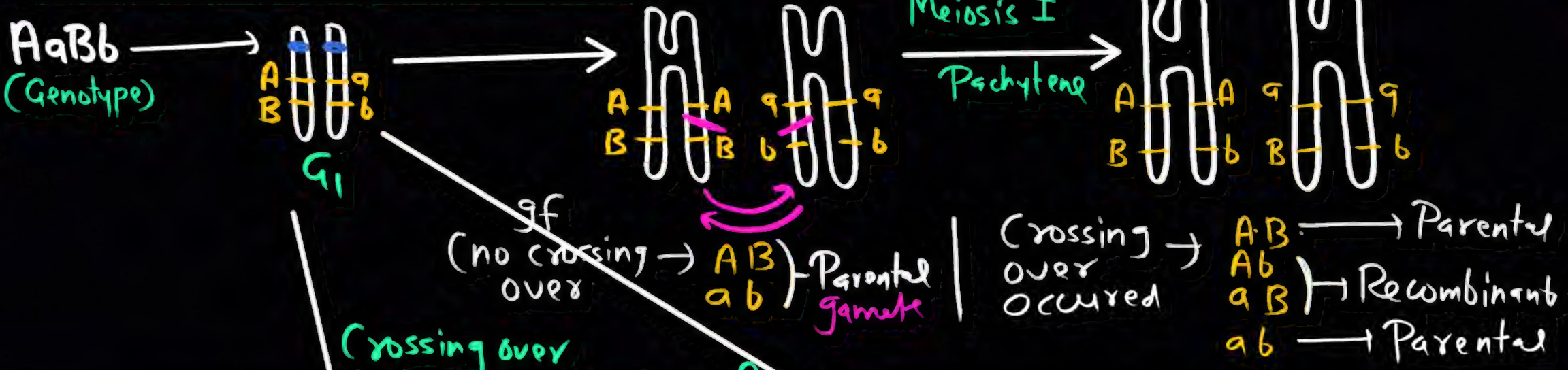
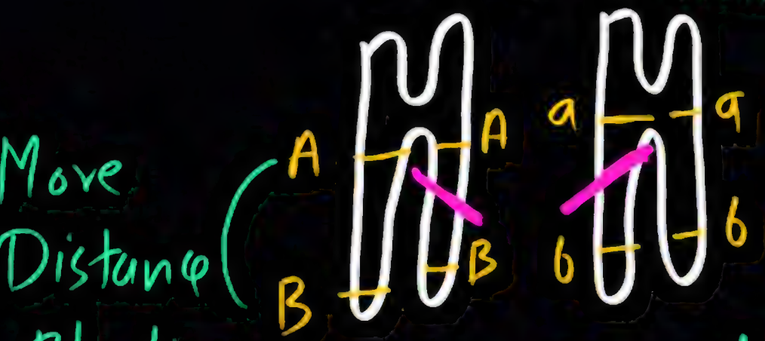
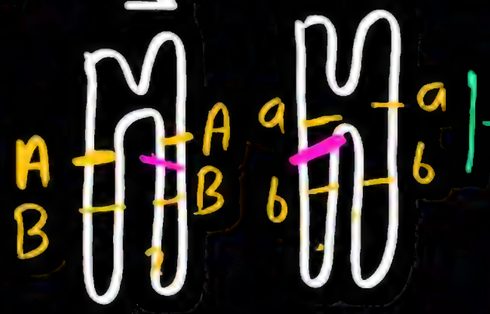


Crossing over Depend on Distance of linked Gene



Move Distance B/w linked gene → More Chance of Crossing over → more Recombinant



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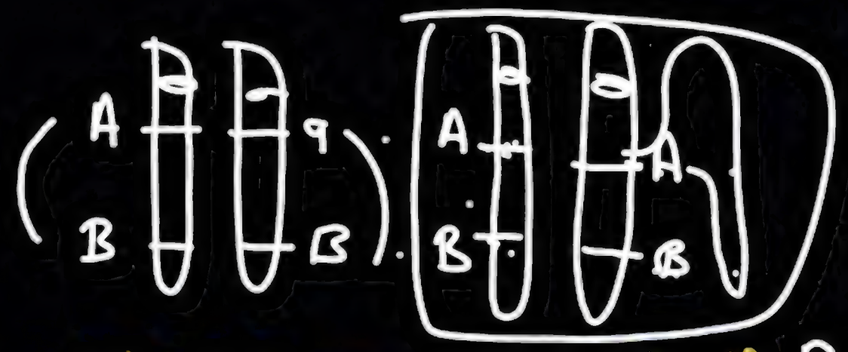


Q9 Genotype AaBB Show linkage this means
(a) A & B on same chromosome (b) B & B on same chromosome (c) a & B on same chromosome (d) Both a & c

Q10 Which Genotype Form Same no. of gametes in independent assortment & linkage
(a) AaBb (b) AABB (c) TtRr (d) TtRRYy

AaBb → IA = 4 → Linkage = 2
TtRRYy → I.A = 4 → L = 2

Q11 Linkage increase
(a) Parental type (b) Recombinant (c) independent assortment (d) all

Q12 linkage is over come By
(a) independent assortment (b) crossing over (c) Recombinant (d) Both a & b

Q13 Chance of crossing over in more if two genes are
(a) less distance (b) close (c) at more Distance (d) all

About linkage

(test cross) ✓

AaBb → Independent assortment → P = 50% ✓ Min
R = 50% → Max. ✓

AaBb → linkage → no crossing over → P = 100%
R = 0%

Two gene → A & B → linked → Recombinant - 10%
P & Q → linked → Recombinant → 30%

Distance of P & Q is more than Distance B/w A & B

Distance Inc. linked gene →

Recombinant → 0% ——— 50% (max)

Incomplete linkage

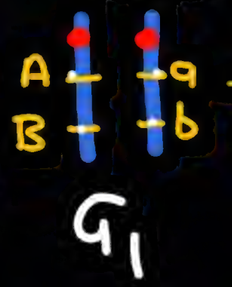
Parental → 100% ——— 50% (min)

Complete linkage

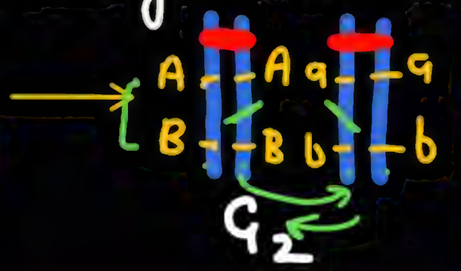
Independent assortment

← Strength of linkage

How linkage can be overcome

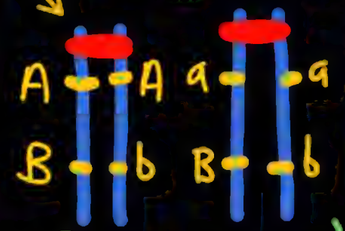


G_1



G_2

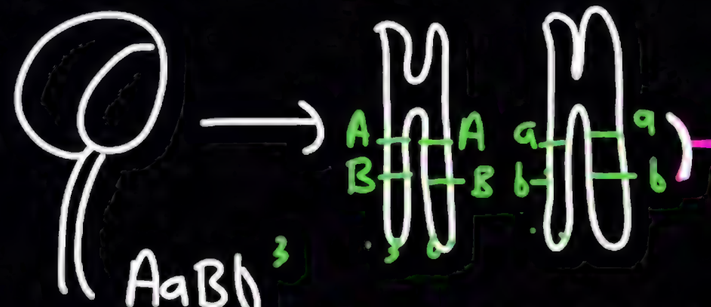
Crossing over



Crossing over Inc → Recombinant

P - min → 50% → Independent assortment
P - max - 100 → Complete linkage (no crossing over)

R - Recombinant → Max - 50% (Independent assortment)
R → min → 0% → linkage no crossing over

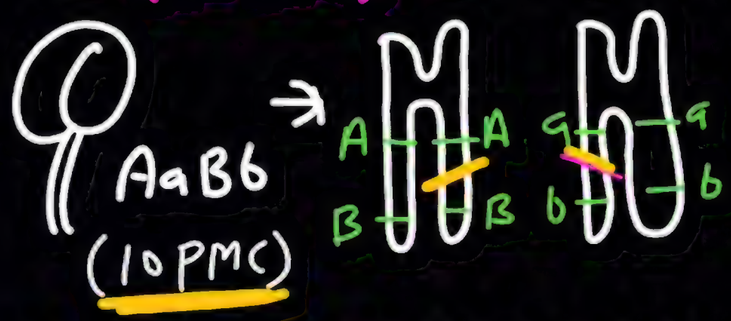


AaBb (10 PMC)

→ no crossing over → P = 100% ✓
R = 0% ✓

AB, ab → 40 Pollen

Complete linkage



AaBb (10 PMC)

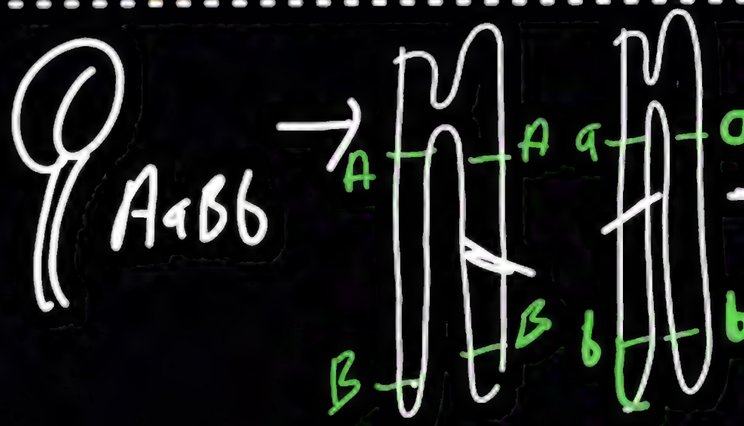
→ 10 PMC

- 5 PMC → no crossing over → P = 20 Pollen (AB, ab) ✓
- 5 PMC → crossing over occur → 10 Pollen (AB, ab)

10 Pollen – Recombinant (Ab, aB)

30 Pollen (Parental) 75%
10 Recombinant = 25%

Incomplete linkage



AaBb

→ 8 PMC → crossing over → R = 16 pollen, P = 16 pollen

2 PMC → No crossing over → P = 8 pollen

Incomplete linkage P = 60%, R = 40

(more chance of crossing over)

observation

TtRr x ttrr → TtRr, Ttrr, ttRr, ttrr → R

(a) If no linkage than → Independent assortment occur → test cross → Parental → 50%. Recombinant → 50%.

(b) If linkage occur → no crossing over → Parental → 100%. Recombinant → 0%.

(c) Crossing over occur in Meiosis I / Pachytene phase B/w non-sister chromatid

(d) Crossing over can increase → Recombinant and decrease → Parental

(e) Parental maximum value → 100%.
Parental minimum value → 50%.

Recombinant maximum value → 50% (Independent assortment)
Recombinant minimum value → 0% (Complete linkage)

Type of linkage

(a) tight / complete / closely linked → Recombinant → Zero → complete
Recombinant – very low → closely linked

(b) Incomplete / loosely linked → Gene link → But cross over occur
(Recombinant less than 50%.
More than 0%.

Ex → T t R r × t t r r (test cross) →
T t R r – P
T t r r
t t R r } – R
t t r r – P.

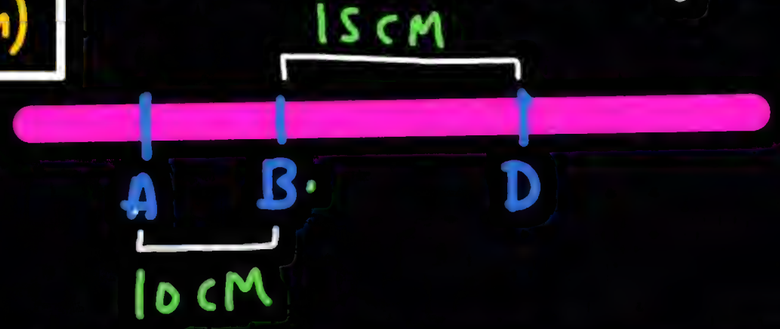
	Ratio	Parental	Recombinant	Type of interaction
①	1 : 1 : 1 : 1	50%	50%	Independent assortment.
②	3 : 1 : 1 : 3	75%	25% = 2/8	Incomplete linkage
③	7 : 1 : 1 : 7	P = 87.5%	R = 2/16 = 12.5%	Incomplete linkage
④	15 : 1 : 1 : 15	P = 93.75	R = 6.25%	Incomplete linkage
⑤	1 : 0 : 0 : 1	P = 100%	R = 0%	Complete linkage.

Distance dec. B/w linked gene

linkage Map

Sturtevant → student of Morgan ⟶ %age of Recombinant is Directly proportional to Relative Distance B/w linke gene

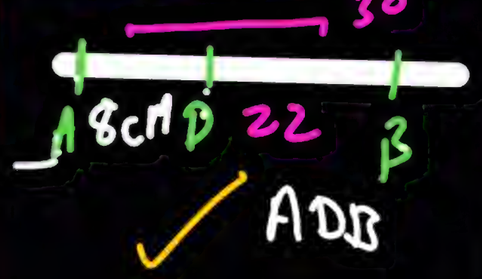
1% Recombinant = 1 map unit = 1cM (Centimorgan)



– Relative position of Gene on chromosome is known as linkage Map / Genetic map

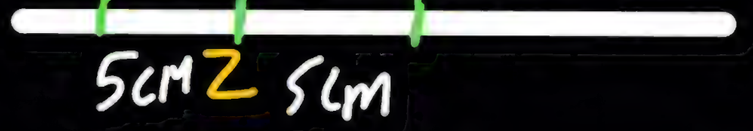
Q Three gene → A & B → 30% Recombinant
B & D ⟶ 78% Parental (Sequence)
A – B ⟶ 30 CM (R – 22%)
B → D → 22% Recombinant = 22 cM

X



✓ ADB

Q Three Gene → X, Y, Z are linked
X & Y ⟶ 10 CM X & Z → 5 CM
Y & Z → 5 CM
(Sequence?)



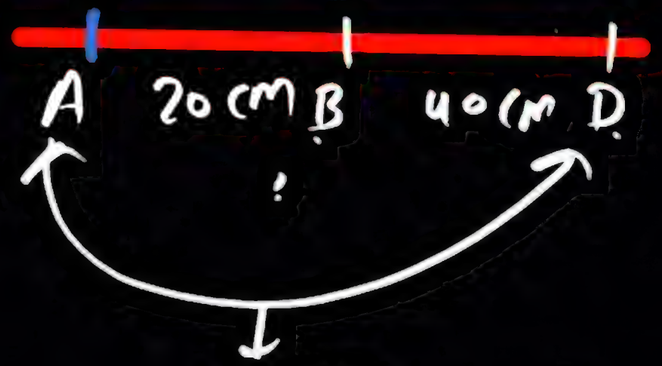
→ XZY

Q Three Gene → A, B, D

A & B → 20% Recombinant ⟶ A & B ⟶ 20 CM

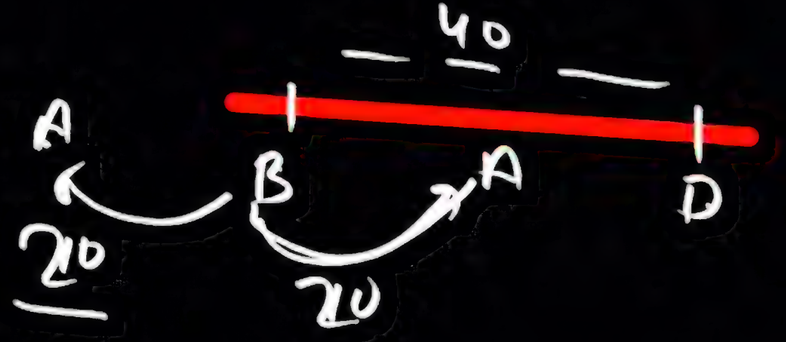
B & D → 60% Parental ⟶ R = 40% → B & D ⟶ 40 CM

Sequence



60 cm

↳ 60% R



BAD
DAB

wing showed 37.2 per cent recombination. His student Alfred Sturtevant used the frequency of recombination between gene pairs on the same chromosome as a measure of the distance between genes and 'mapped' their position on the chromosome. Today genetic maps are extensively used as a starting point in the sequencing of whole genomes as was done in the case of the Human Genome Sequencing Project, described later.

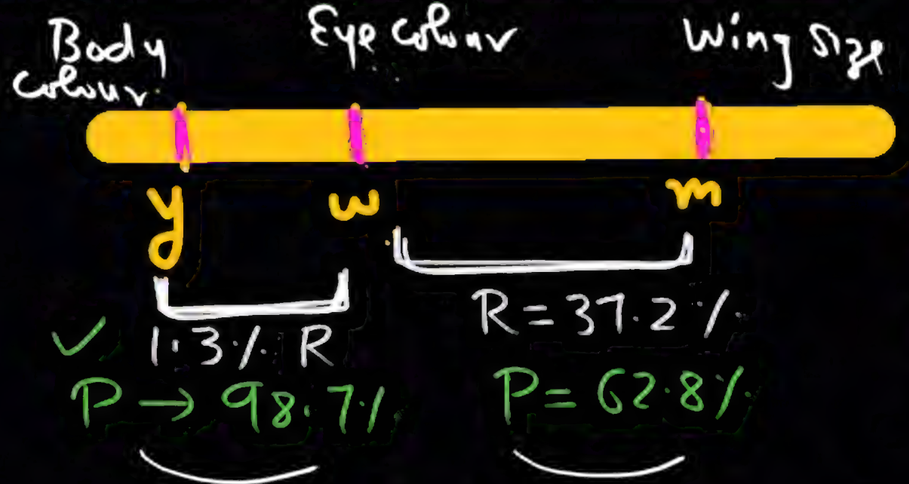
Cross By T. H Morgan on Drosophila

P x P
↓
F1
↓ selfing
Result

→ T.H Morgan ⟶ Cross Perform on Drosophila ⟶ Dihybrid cross like Mendel
(Expected Result – 9:3:3:1 ⟶ But Due to linkage → this result not come)

→ Three character select → present on X-chromosome (Female → two X-chromosome
Male → one – X-chromosome)

Characters on X-chromosome

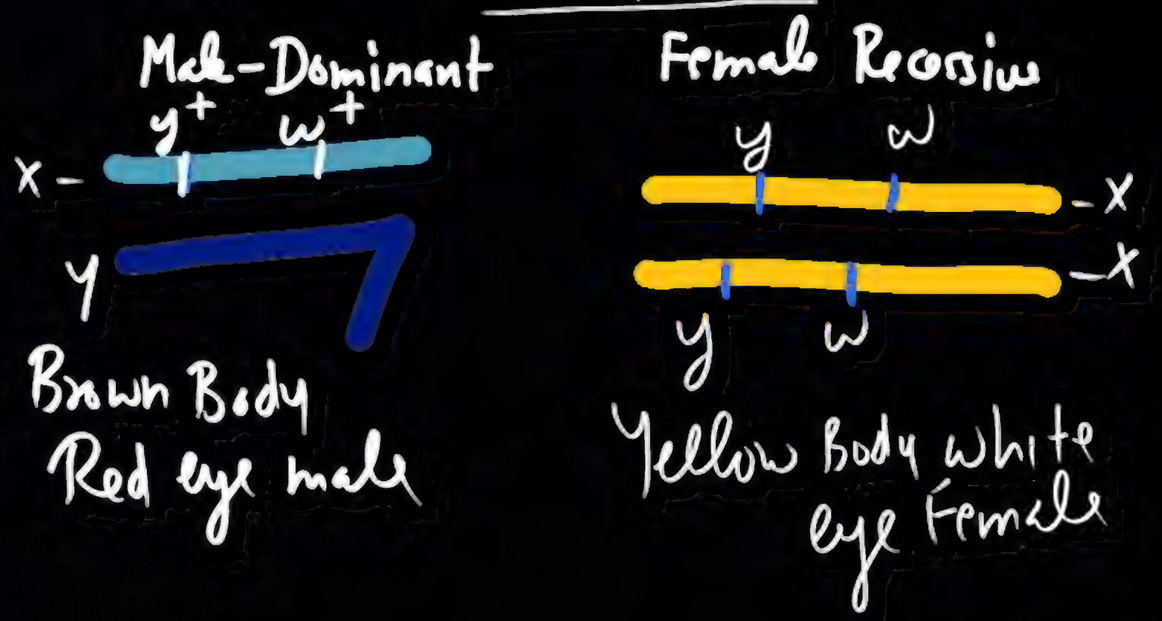


B E W

Character	Dominant	Recessive
B Body colour	Brown Body $-y^+$	Yellow Body $-y$
E Eye colour	Red eye $-w^+$	White eye $-w$
W Wing size	normal wing $-m^+$	miniature wing $-m$

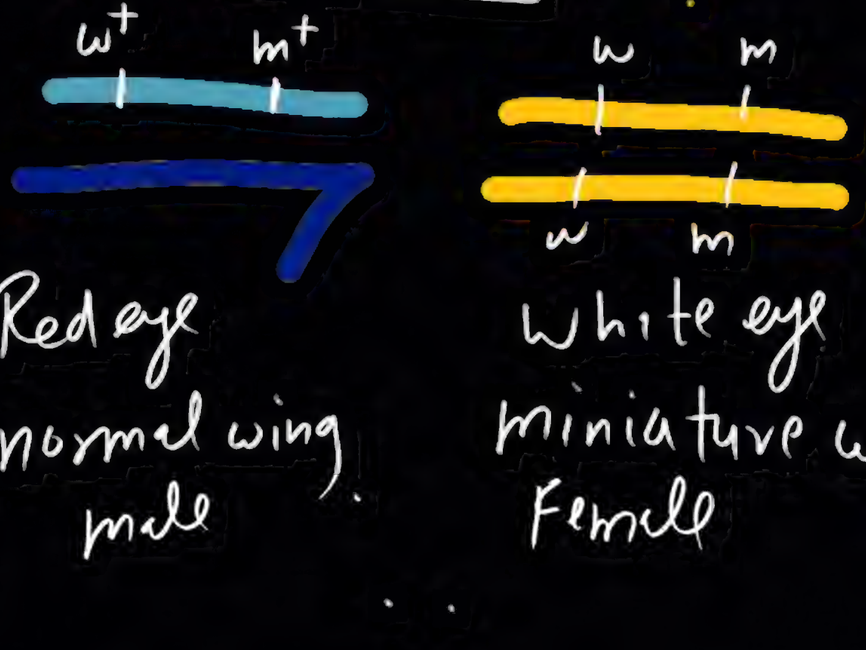
(Body colour eye colour

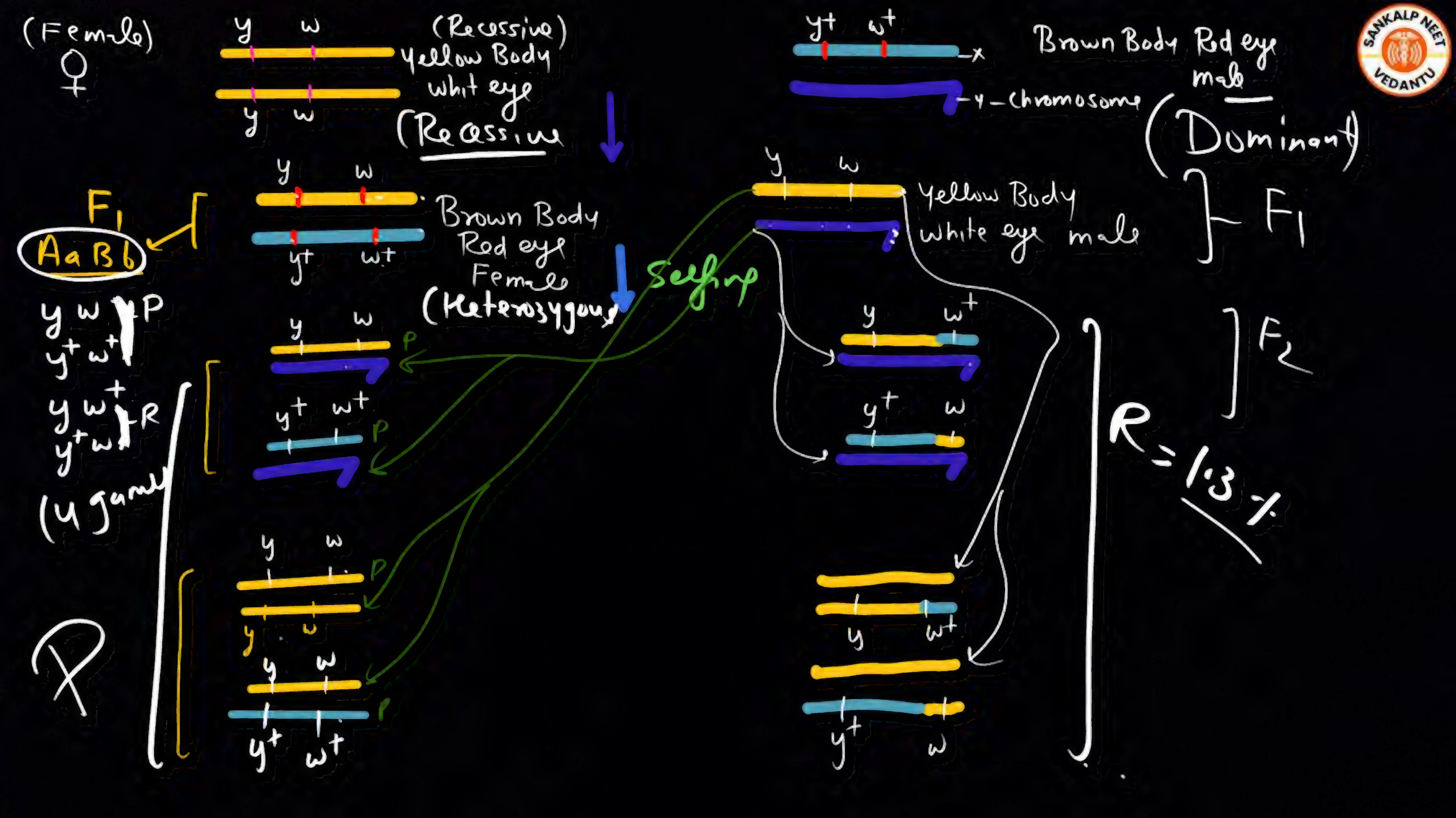
Dihybrid I

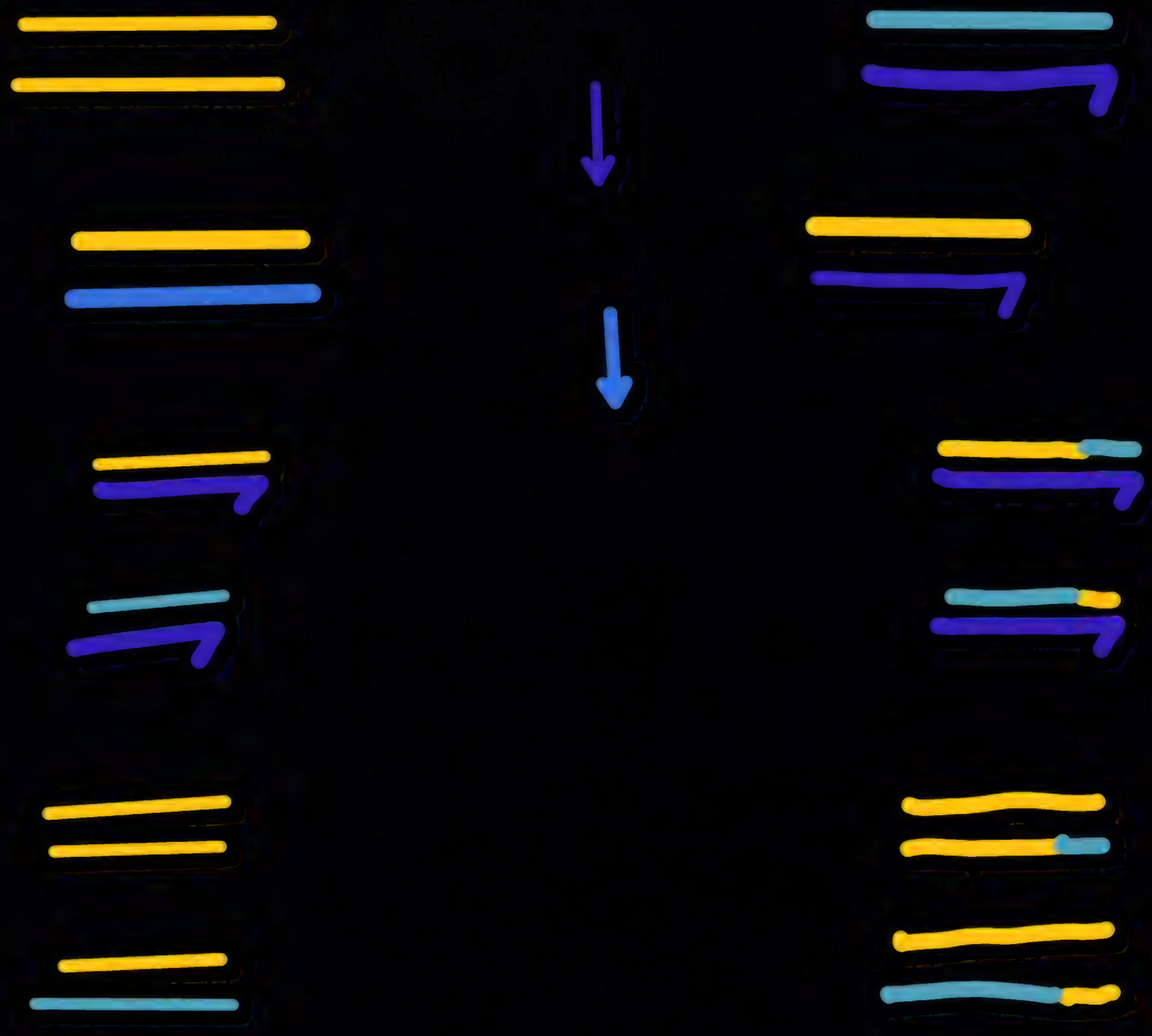


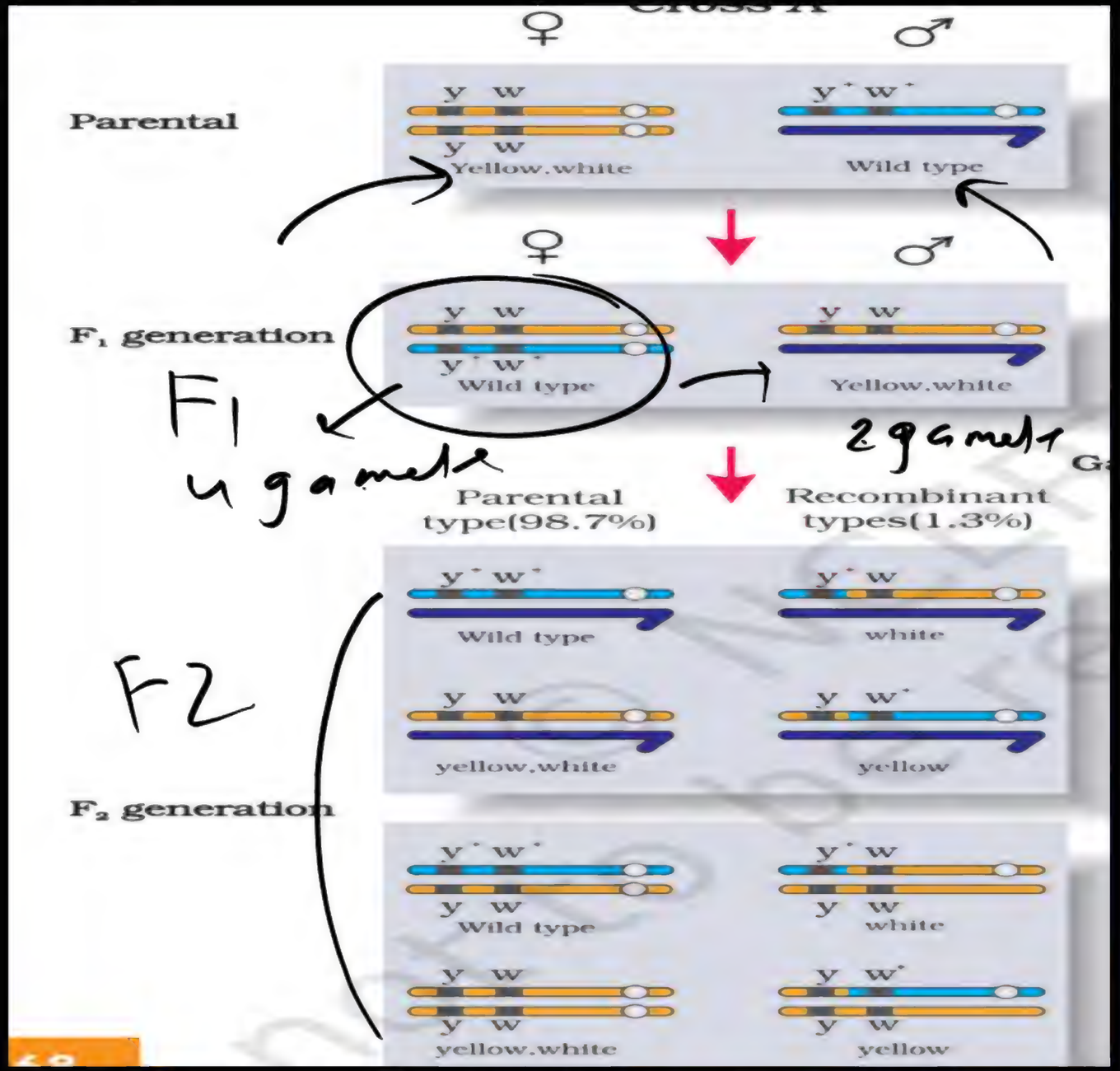
(Eye colour & wing size)

Dihybrid – II




(Female)
♀
y w
(Recessive)
Yellow Body
whit eye
(Recessive
y w
y w
y+ w+
Brown Body
Red eye
Female
(Heterozygous
F1
AaBb
Selfing
y w P
y+ w+
y w+ R
y+ w
(4 gametes
P
y w
P
y+ w+
P
y w
P
y w
P
y+ w+
P
y+ w+
Brown Body Red eye
male
(Dominant
y+ w+
X
Y-chromosome
y w
Yellow Body
white eye male
F1
y w+
y+ w
y w+
y+ w
F2
R = 1.3 %
SANKALP NEET
VEDANTU

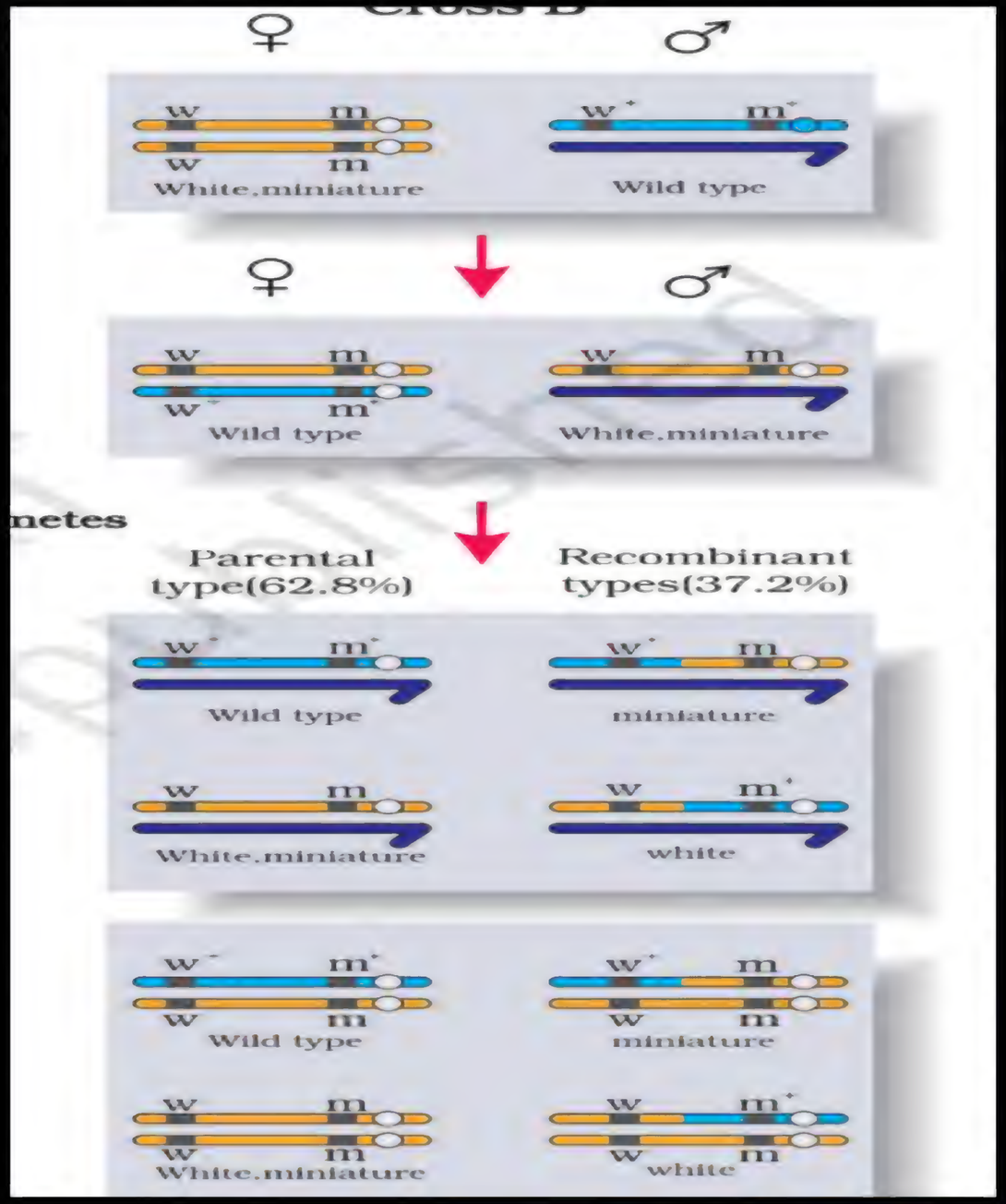


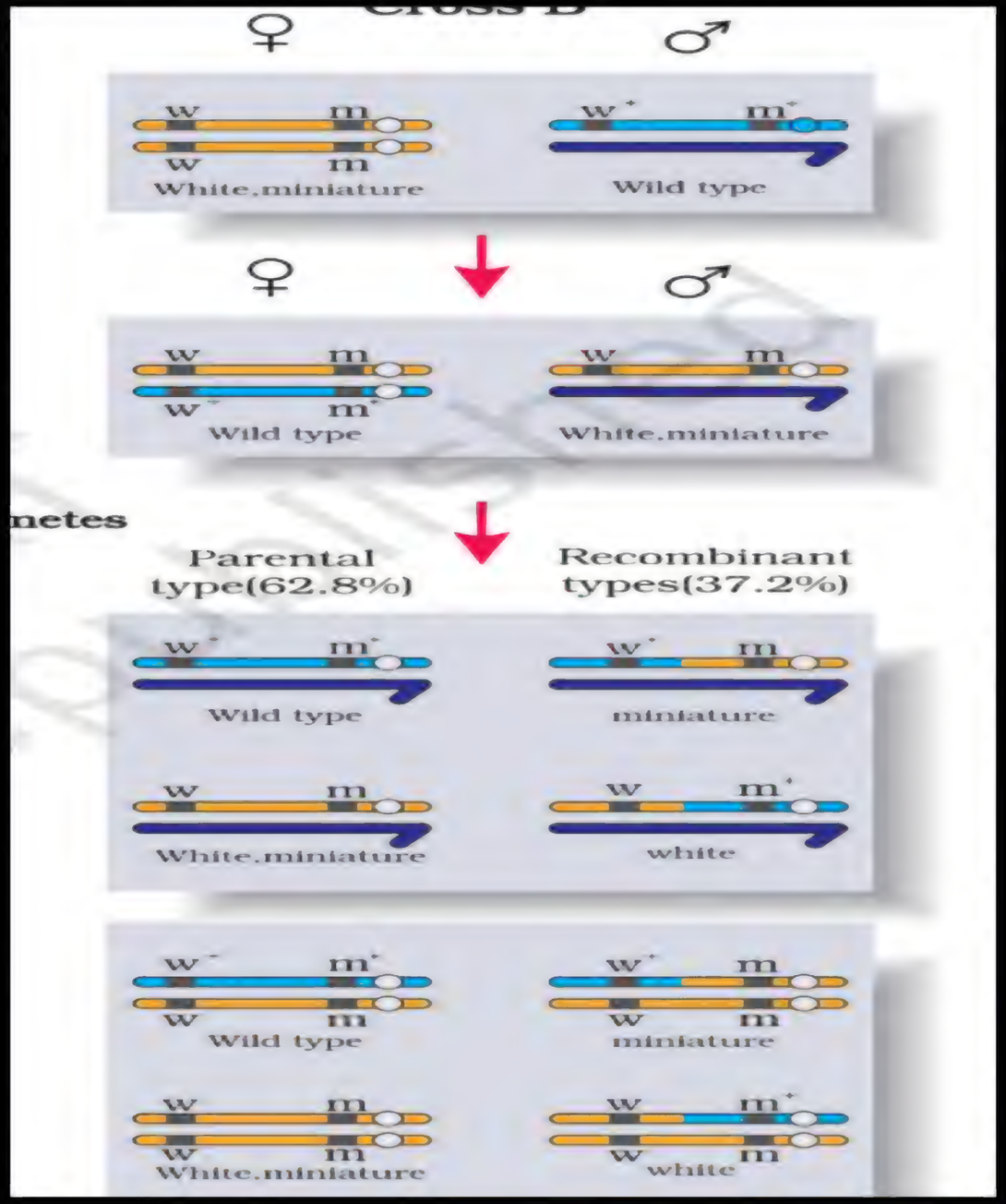


AaBb

P (AB, aB, Ab, ab) — R

P ($y^+y w^+w$, y^+w^+, $y w^+$, y^+w, $y w$) — R


♀
♂
w m
w m
White,miniature
w+ m+
Wild type
♀
♂
w m
w+ m+
Wild type
w m
White,miniature
netes
Parental type(62.8%)
Recombinant types(37.2%)
w+ m+
Wild type
w+ m
miniature
w m
White,miniature
w m+
white
w+ m+
w m
Wild type
w+ m
w m
miniature
w m
w m
White,miniature
w m+
w m
white


♀
♂
w m
w m
White,miniature
w+ m+
Wild type
♀
♂
w m
w+ m+
Wild type
w m
White,miniature
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Wild type
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miniature
w m
White,miniature
w m+
white
w+ m+
w m
Wild type
w+ m
w m
miniature
w m
w m
White,miniature
w m+
w m
white

Q1 Two linked gene A & B are Closely linked which is not possible

(a) Recombinant 50% (b) Parental 100% (c) Independent assortment (d) Both a & c

Q2 Distance B/w two linked gene is Directly proportional to

(a) Recombinant (b) Chance of cross over (c) Parental (d) Both a & b

Q3 Maximum Distance B/w ___ on one X-chromosome in Drosophila

(a) yellow Body & white eye (b) yellow Body miniature wing (c) Brown Body & White eye (d) white eye & miniature wing

Q4 Linkage Result not seen in

(a) Apical Meristem (b) PMC (c) MMC (d) Spermatogonia

Q5 30 CM is a Distance B/w linked gene than Parental % age

(a) 70% (b) 30% (c) 50% (d) 35%

Q6 Linkage is Directly proportional to
(a) chance of cross over (b) Recombinant (c) Parental (d) all

Q7 Which is not Dominant trait in Drosophila
(a) Yellow Body (b) Brown Body (c) Red eye (d) Normal wing

Q8 Distance B/w w^+ m^+ in Drosophila cross is
(a) 1.3 CM (b) 37.2 CM (c) 62.8 CM (d) 98.7 CM

Q9 Linkage map is
(a) Actual position of Gene (b) Relative position of Gene (c) only two linked gene (d) none

Q10 White eye & miniature wing distance is
(a) 38.5 (b) 37.2 (c) 1.7 (d) all

Q11 Gametes produce By Heterozygous Red eye normal wing Female is

(a) $\frac{w^+ m^+}{w\ m}$ (b) $\frac{w^+\ m}{w\ m^+}$ (c) $\frac{w^+ m^+}{w^+ m}, \frac{w\ m}{w\ m^+}$ (d) none

Q12 Parental Gametes From Heterozygous Brown Body Red eye Female

(a) $y^+ m^+, ym$ (b) $\frac{y^+ m^+}{y^+ m}$ (c) $\frac{y^+ w^+}{y\ w}$ (d) $\frac{y^+ w}{y\ w^+}$

MANTHAN NEET 2025(१०१२०)

SANKALP NEET VEDANTU

principle of inheritance

lecture- १०

Botany

TARUN SIR

Topics

introduction-gene,allele ,chromosome ,haploid,diploid

Mendelian principle- hybridisation experiment,result,law and cross

Gene interaction- incomplete dominance,co-dominance and muliple allele, polygenic inhritance

DOPA prime-1

Chromosomal theory, linkage and sex determination

Dopa prime-2

Mutation,pedigree analysis , genetic disroder

Dopa prime-3

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(a) Recombinant 50% (b) Parental 100% (c) Independent assortment (d) Both a & c

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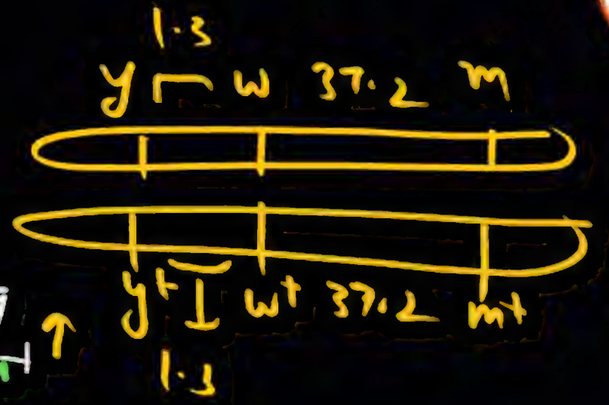
(a) Apical Meristem (b) PMC (c) MMC (d) Spermatogonia

Q5 30 CM is a Distance B/w linked gene than Parental %age
(a) 70% (b) 30% (c) 50% (d) 35%

30 cm → 30% R, P = 70%

Now clear

Q6 Linkage is ~~Directly~~ proportional to
(a) Chance of cross over (b) Recombinant (c) Parental (d) all



Q7 Which is not Dominant trait in Drosophila
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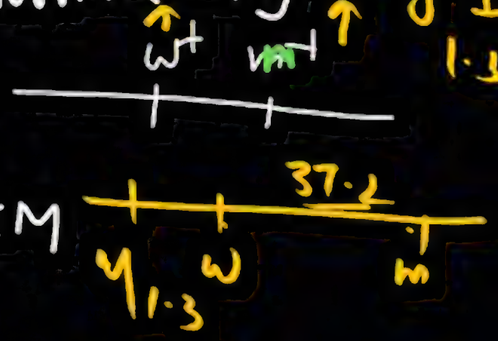


Q9 Linkage map is
(a) Actual position of Gene (b) Relative position of Gene (c) only two linked gene (d) none

Mutation

term By – De vries (Experiment on – Evening primrose Oenothora lamarckiana)

(Responsible For variation)

definition – Sudden inheritable change in DNA

Explanation → Mutation occur in two type of cells

- Somatic cell Mutation → Ex – skin cell ✓
- Germ cell mutation → Ex – spermatogonia ✓

Inheritable (two meaning)

- one organism → to its progeny ✓
- one cell → Two daughter cell] Ex – Cancer cell
  to mutation move into

Type of mutation

I Change in chromosome number →

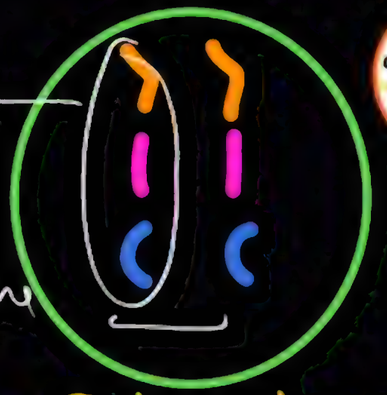
II Change in Chromosome structure (Chromosomal Aberration → main cause of cancer)

III Change in DNA Sequence – Point mutation

I Change in chromosome number

- Chromosome visible when cell Divide (Mitosis, Meiosis)
- Change in chromosome number → Abnormal cell Division

Genome ← (Total two copy of Genome



Two type of change in chromosome number

I Polyploidy – More than two Copy of Genome

3n, 4n, 5n

(natural & Artificial)

→ Easily visible in plants

→ When cell undergoing Mitosis

→ Colchicine (Artificial) → prevent spindle Formation → Polyploidy occur

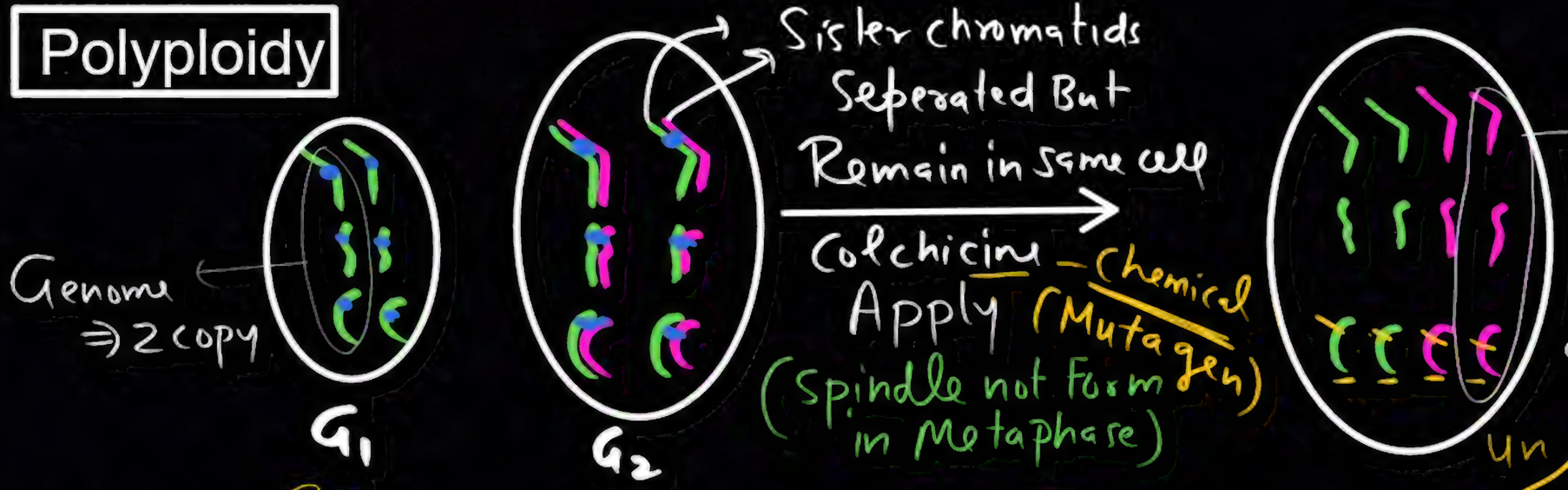
II Aneuploidy → One or two Extra chromosome or decrease

2N+1, 2N-1, 2N-2, 2N+2

→ During Meiosis → Anaphase I Chromosome pair seperate By Disjunction

→ Due to non-disjunction Chromosome Pair not seperate

Polyploidy



Q one locus More than two allele in organism
(a) haploid (b) Diploid (c) Polyploid
(d) none

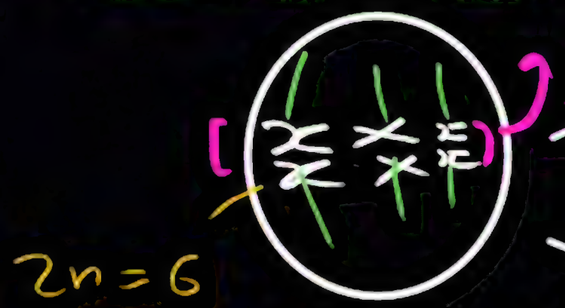
* Animals/Humans – Polyploid not viable
* Plants polyploid → Survive
* Any Benefit of polyploidy – For Quantitative trait (More Dominant more trait Express)

Q1 In case of Pea plant (2n=14) polyploidy can have ___ no. of chromosome
(a) 7 (b) 28 (c) 56 (d) Both b & c
n 4n 8n

Aneuoploidy

— Increase or decrease in one or two chromosome (Cell undergoing meiosis I)

Reason → Paired chromosome in Anaphase I → non-Disjunction show



$2n = 6$

normal Anaphase I → (3) (3) — chromosome (normal)

$n=3$ $n=3$

non-disJunction in Anaphase -I → (4) → Chromosome + 3 (normal $n=3$ gamete) → (7) Zygote $(2N+1)$ (More no. of chromosome)

(2) Chromosome + (3) ($n=3$) normal gamete → (5) Zygote $(2N-1)$ Less no. of chromosome

Q In Aneuoploidy Abnormal number of chromosome is present in (a) gamete (b) Zygote (c) organism (d) all

Human - Genetic Disorder

- 2N+1 → trisomy - Down's Syndrome (21st Extra)
- 2N+1 → Extra X-chromosome (Klinefelter's (male))
- 2N-1 → turner's Syndrome

23 pair → (Meiosis I) non-Disjunction (one pair) → Human cell

24 + 23 (normal gamete) → 47 Zygote 2N+1

22 + 23 normal gamete → 45 Zygote (2N-1)

(a) Trisomic → 2N+1

Increase

→ 2N-1 → one chromosome less → Monosomic

→ 2N-2 → pair Absent → Nullisomic

→ 2N-1-1 → two chromosome Absent Each From Different pair (Double Monosomic)

(b) Double trisomy (2n+1+1)

(c) Tetrasomic (2N+2)

no. of chromosome in Human - Double Monosomic → 44

no. of chromosome in tetrasomic → 2N+2 → 48

Human

II Change in chromosome structure

→ normal cell mutation occur

(Chromosomal Aberration)

1. Deletion – Gene B Delete (Gene Absent)

Remove (Deletion)

A Remove (Deficiency)

2. Deficiency → terminal gene delete

3. Duplication →

4. inversion

Pericentric

Paracentric (without centromere)

Translocation

Homologus

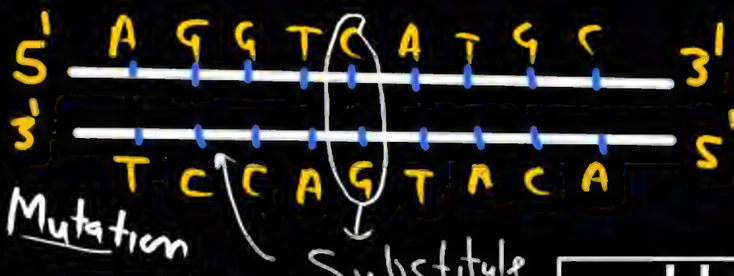
Gene Exchange → B/w non sister chromatid of Homologus Pair – Crossing over

→ (Ex → Myelogenous leukimia)

Gene Exchange B/w Non Homologus pair – Translocation (mutation)

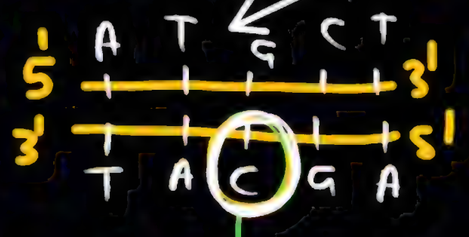
Change in DNA

DNA change occur at Single Point - Point Mutation



Type of mutation

I Substitution

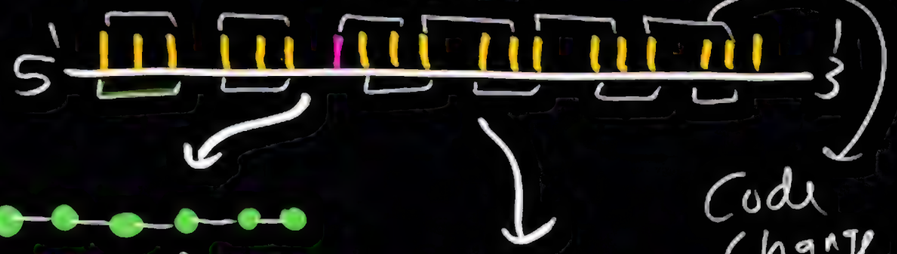


Change (Substitution)

(only one Amino Acid change)

Addition and deletion (Frame Shift Mutation)

(Addition or deletion



Normal protein

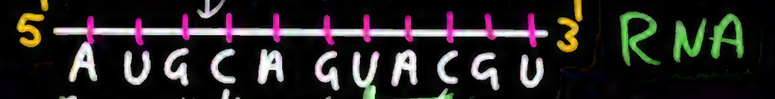
Code Change

all Amino can get change

Addition or deletion occur (more lethal)

How DNA Function

Transcription



Translation

N — AA1 — AA2 — AA3 — C

Polypeptide

DOPA

Q1 Mutation occur in

(a) Dividing cell (b) Permanent cell (c) Somatic cell (d) all

Q2 Mutation is inheritable when it occur in

(a) Dividing cell (b) Cell After mutation which divide (c) Dead cell (d) none

Q3 Aneuploidy Result in

(a) change in species (b) Change in chromosome only in one cell (c) Change in chromosome of all cells (d) none

Q4 Polyploidy Result in

(a) two copy of Genome (b) Many copy of Genome in Gamete (c) Many copy of Genome in Organism (d) all

Q5 Non-disjunction lead to

(a) Aneuploidy (b) Polyploidy (c) Chromosomal Aberration (d) all

Q6 Which have highest no. of chromosome

(a) Nullisomy in Human (b) tetrasomy in Human (c) Monosomic in Human (d) all

Q7 Mark incorrectly matched

(a) Monosomic → 2N-1 (b) tetrasomic → 2N+2 (c) Nullisomic → 2N-1-1 (d) trisomic → 2N+1

Q8 Change in chromosome structure Responsible For

(a) Chromosomal Aberration (b) Cancer (c) chromosomal mutation (d) all

Q9 Translocation occur B/w

(a) two sister chromatic (b) two Homologous chromosome (c) non Homologous Chromosome (d) all

Q10 Substitution mutation in DNA lead to

(a) Change in one Amino Acid (b) Change in two Amino Acid (c) Frame Shift mutation (d) all

MANTHAN NEET 2025(1.0१२.0)

SANKALP NEET VEDANTU

principle of inheritance

lecture- 12

Botany

TARUN SIR

Topics

introduction-gene,allele ,chromosome ,haploid,diploid

Mendelian principle- hybridisation experiment,result,law and cross

Gene interaction- incomplete dominance,co-dominance and muliple allele, polygenic inhritance

DOPA prime-1

Chromosomal theory, linkage and sex determination

Dopa prime -2

Mutation, pedigree analysis, genetic disroder

Dopa prime -3

Type of trait

Dominant
- Express in Both Homozygous & Heterozygous Condition (AA or Aa)

Recessive
- Express only in Homozygous state (aa)

Genetic trait (two type)

I Disease ✓
- Ex - Sickle cell Anaemia
- Colour Blindness

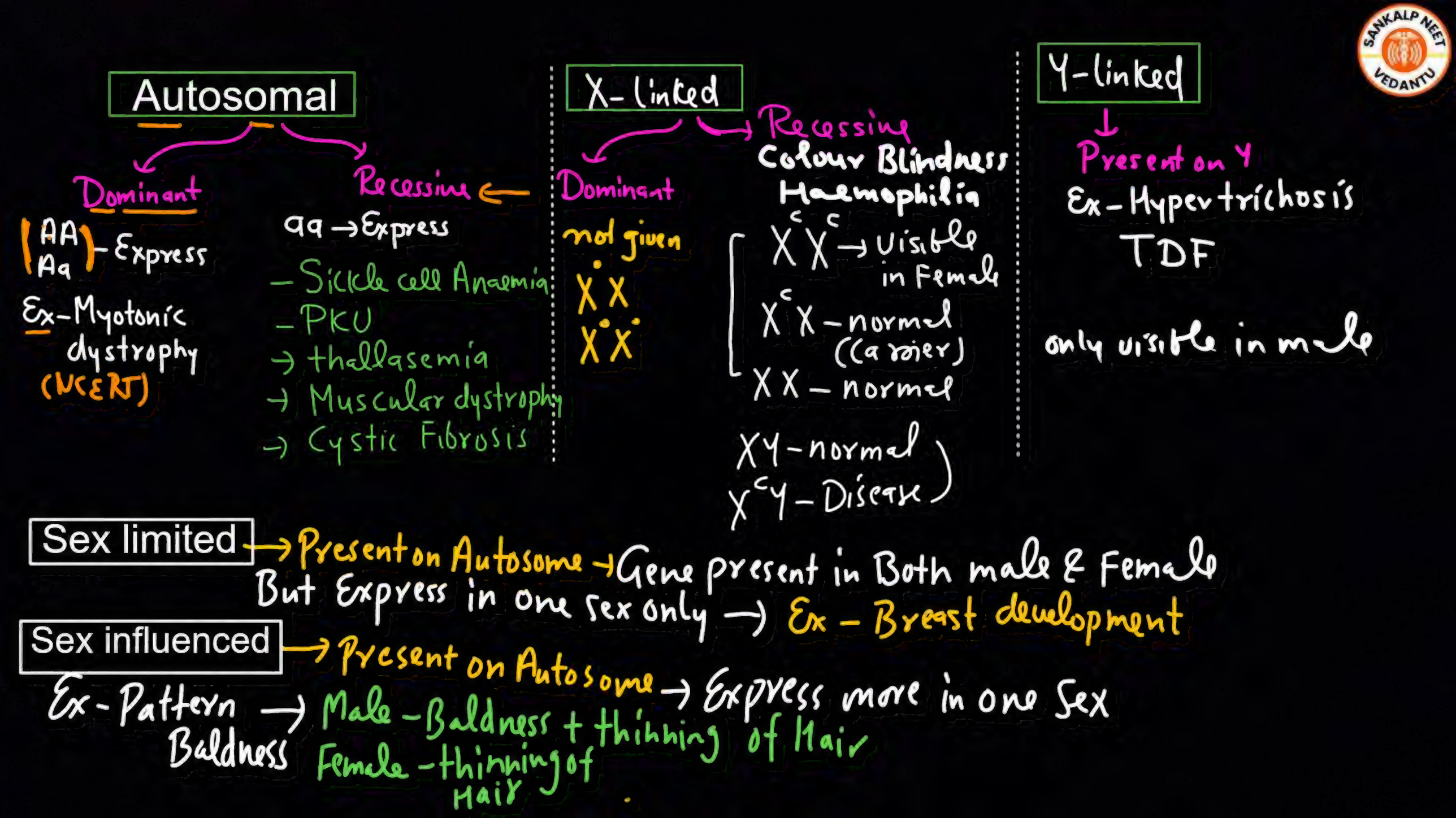
II Non Disease ✓
- → Fuse & Free Ear lobe
- → tongue Roller or non Roller
- → PTC tasker, non taster

I Y linked → on Y-chromosome – Express only in male
- Ex - Hypertrichosis (Hair on pinna), TDF (testis Determing Factor)

II X linked / Sex-linked → Present in male & Female Both
- (male – one X-chromosome, Female → two X-chromosome)
- Ex - Colour Blindness, Haemophilia

III Autosomal
- ↳ Present on Autosome → male & Female two Autosomes
- ↳ No Difference in male & Female → Ex - Sickle cell Anaemia

SCA – Sickle cell Anaemia
- It is Autosomal Recessive Disease


Autosomal
Dominant
AA
Aa
Express
Ex-Myotonic dystrophy
(NCERT)
Recessive
aa → Express
- Sickle cell Anaemia
- PKU
→ thallasemia
→ Muscular dystrophy
→ Cystic Fibrosis
X-linked
Dominant
not given
Recessive
Colour Blindness
Haemophilia
X^cX^c → Visible in Female
X^cX - normal (Carrier)
XX - normal
XY - normal
X^cY - Disease
Y-linked
Present on Y
Ex-Hypertrichosis
TDF
only visible in male
Sex limited → Present on Autosome → Gene present in Both male & Female
But Express in one sex only → Ex - Breast development
Sex influenced → Present on Autosome → Express more in one Sex
Ex-Pattern Baldness → Male - Baldness + thinning of Hair
Female - thinning of Hair

Pedigree Analysis

meaning – Study of Genetic trait By Family History or Family tree

Important point

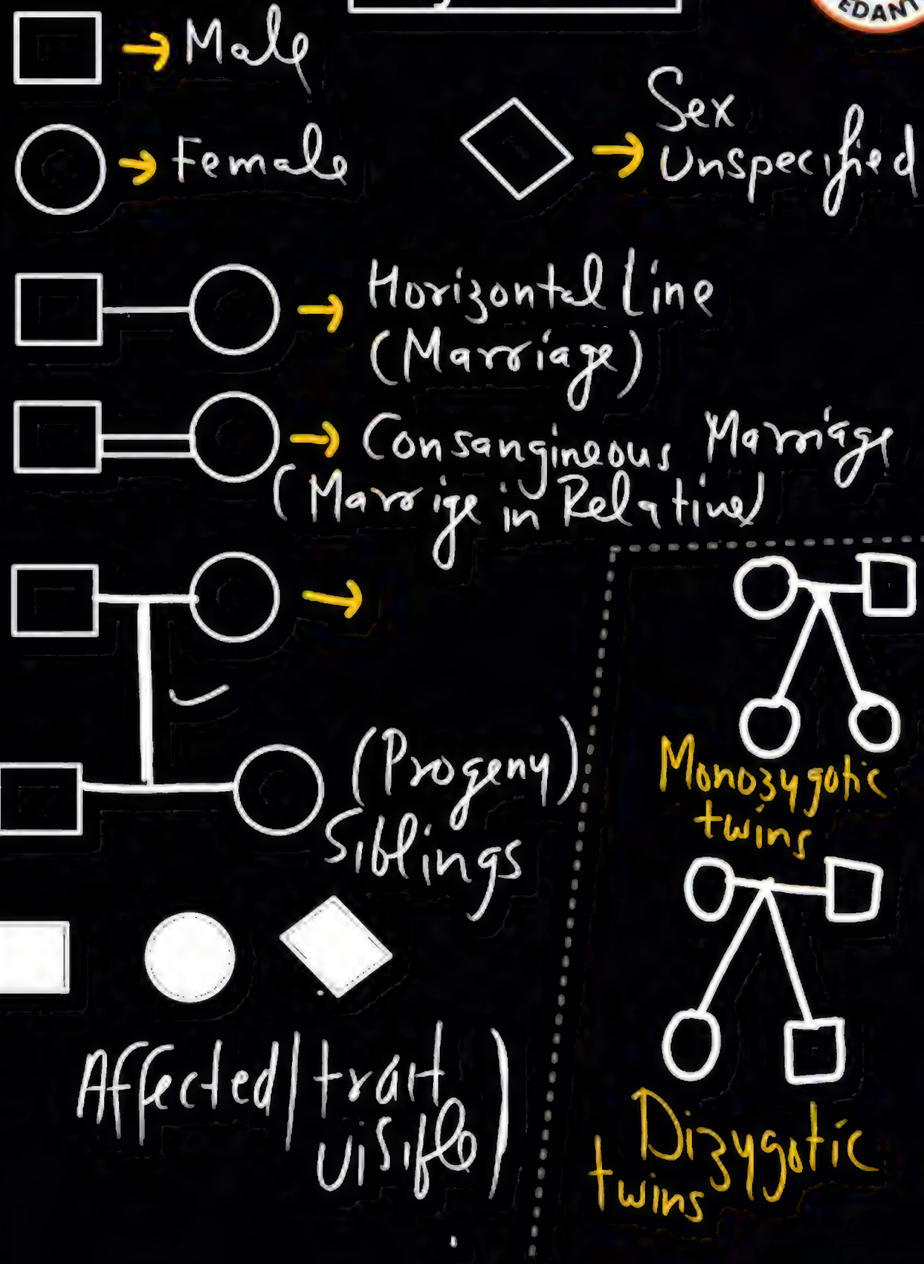
(a) Some Disease present – Human have Some idea (Genetic)

(b) After mendel work Rediscovery (Genetic trait → Study start)

(c) Control cross not possible in Human (Study Family in Ancestor)

(d) Use Symbols For male & Females

Symbol



Some important observation

- Genotype For → Autosomal — use → AA, Aa, aa
  → Sex linked, Y-linked XY
  XX, XY

- For Autosomal For male & Female we use genotype
- For Sex linked we use Genotype →

male → XY (Affected), XY (normal)

Recessive → X^cX (Affected)

XX, XX (Female)

→ Dominant (Disease) → Affected – Aa, AA
→ Recessive → Affected → aa → ♂ ♀
→ normal → Aa, AA → ♀ ♂

Q Myotonic dystrophy – incorrect

(a) Possible in male — ~~♂~~ Aa, AA

(b) Possible in Female — (d) ♀ – Aa, AA

Q Colour Blindness → (Sex linked Recessive)

(a) ♀ – XX (b) ♀ – X^cX^c (c) ♀ X^cX, X^cY ~~(d) ♀ X^cX^c, X^cY~~

Q Sickle cell Anemia (A·R) in male

(a) ♀ – aa × ~~♂~~ ♂ – aa

(b) ♂ – Aa

(c) ♂ – aa

Q Given is Autosomal Recessive ✓ aa
which is incorrect ✗

AA | Aa ✓

(a) P aa — Aa — R aa — Q aa — Aa — Aa

(i) P = Aa Q = Aa
(ii) P = aa
(iii) P, R — aa
(d) R = aa

Autosomal Recessive → aa

Autosomal Dominant
(Dark → AA, Aa)
Normal → aa

Q Given pedigree — Sex linked Recessive

XY — XX

P — Carrier — Q XY — X°X — R X°Y — X°Y

P: X°Y
Carrier: XX ✓ x, X°X ✓

Affected Female → X°X°
Affected male → X°Y

Aa — aa — Aa — aa — Aa — AA — Aa — Aa

AR → Dark - aa
Normal AA, Aa

AD
normal - aa aa
Dark - Aa AA

Important observation

(a) Autsomal Recessive → aa aa — normal Aa AA

(b) Autosomal Dominant → AA or Aa — aa

(c) Sex-linked Recessive → X^cX^c X^cY | X^cX, XX | XY

(d) Y-linked → XY^c — XY^c

(e)

(Parent normal Progeny Disease never Autosomal Dominant)

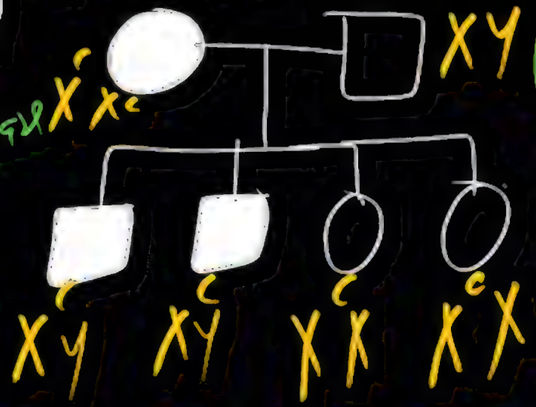
X

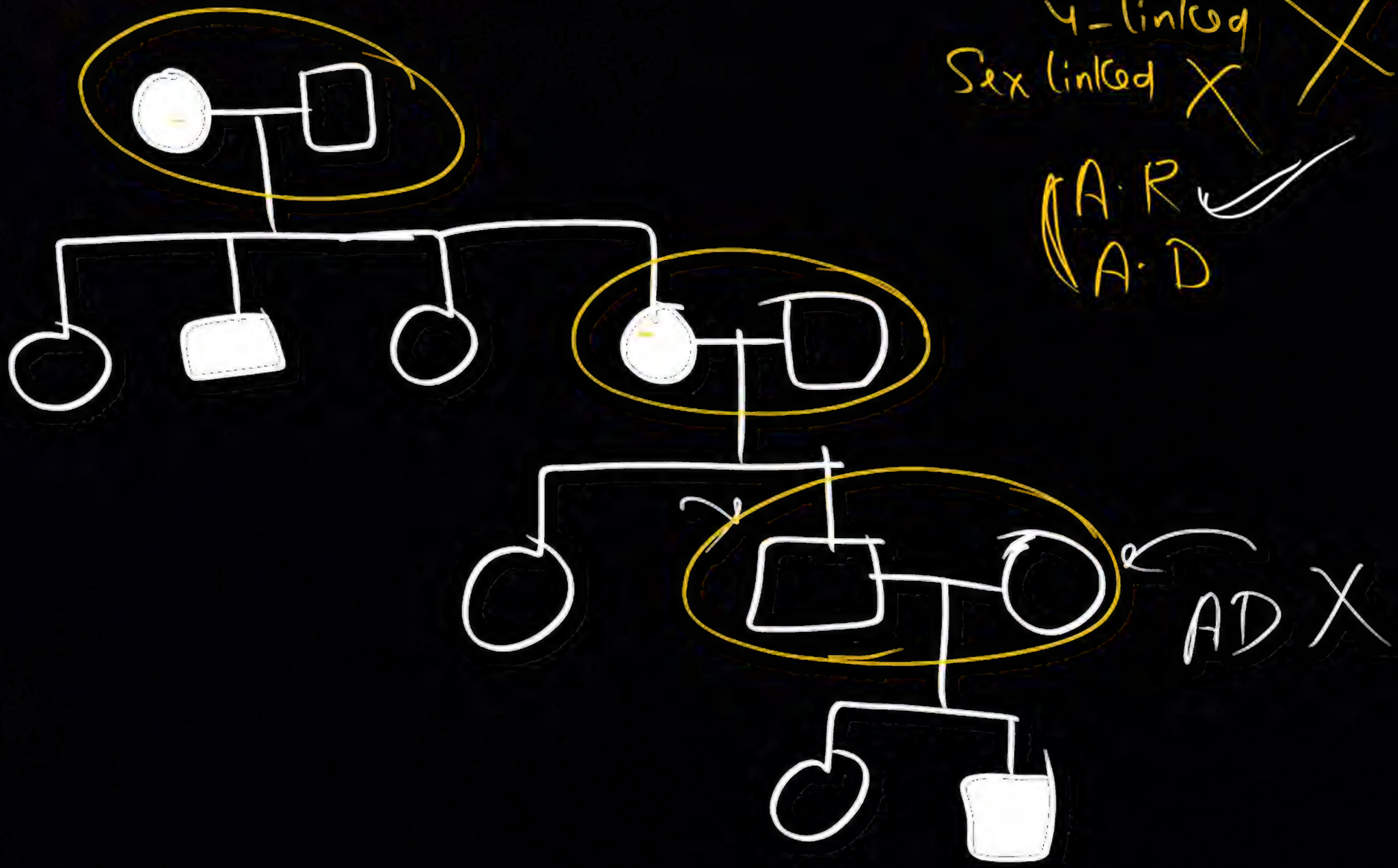
(d) aa → AR

Parent affected Progeny normal (never Autosomal Recessive)

(c) Sex linked Recessive → Female affected when Father (Daughter) affected

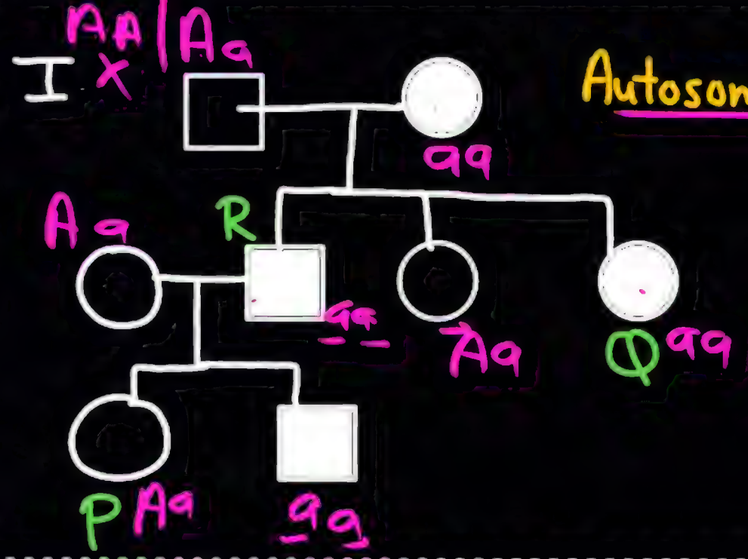
Affected Female, all son Affected




Y-linked
Sex linked X
A·R
A·D
AD X

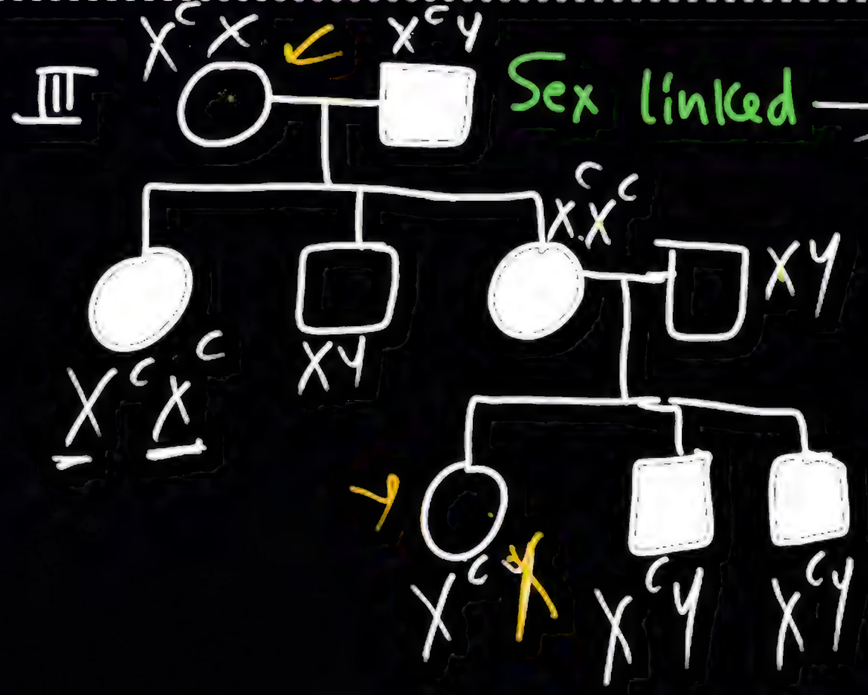
Type of Questions

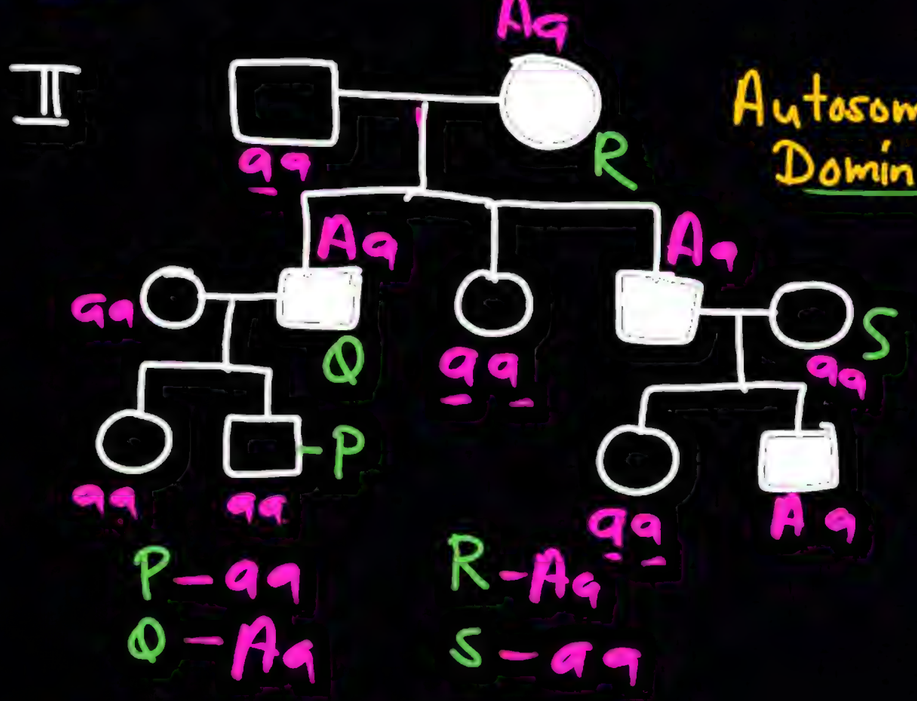
I Unknown genotype



Autosomal Recessive

P → Aa
Q – aa
R → aa

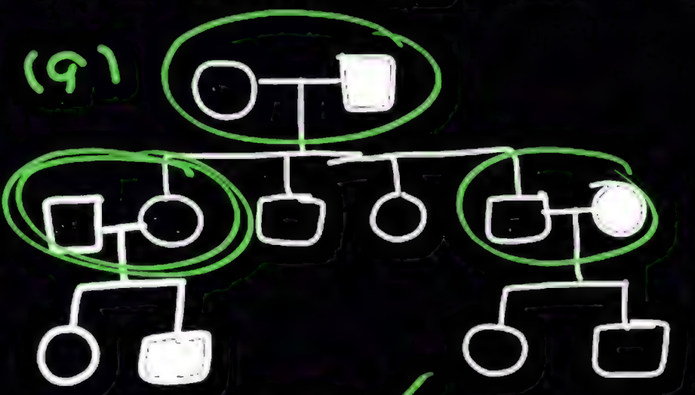




Autosomal Dominant

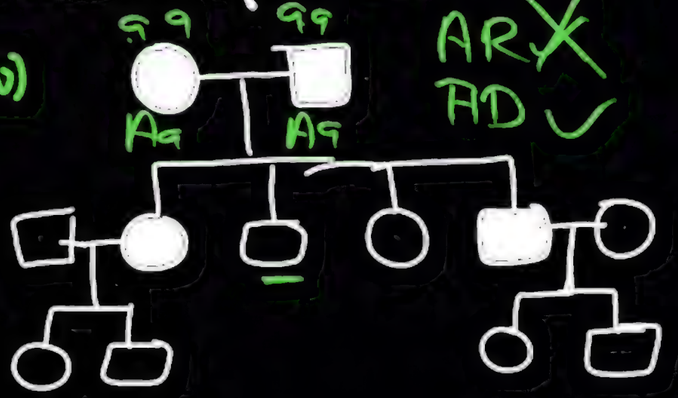
II Identify → Autosomal Recessive/Dominant

(a)



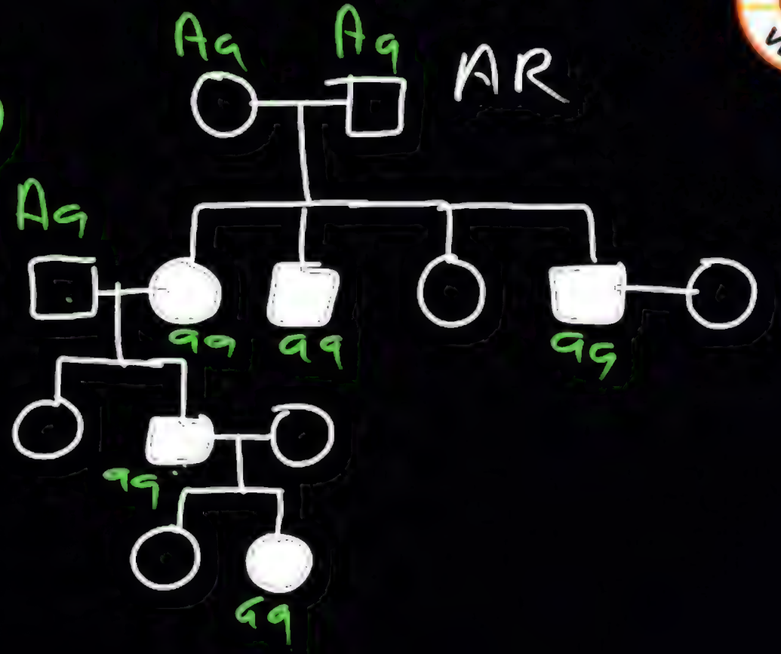
AR ✓
ADX

(b)



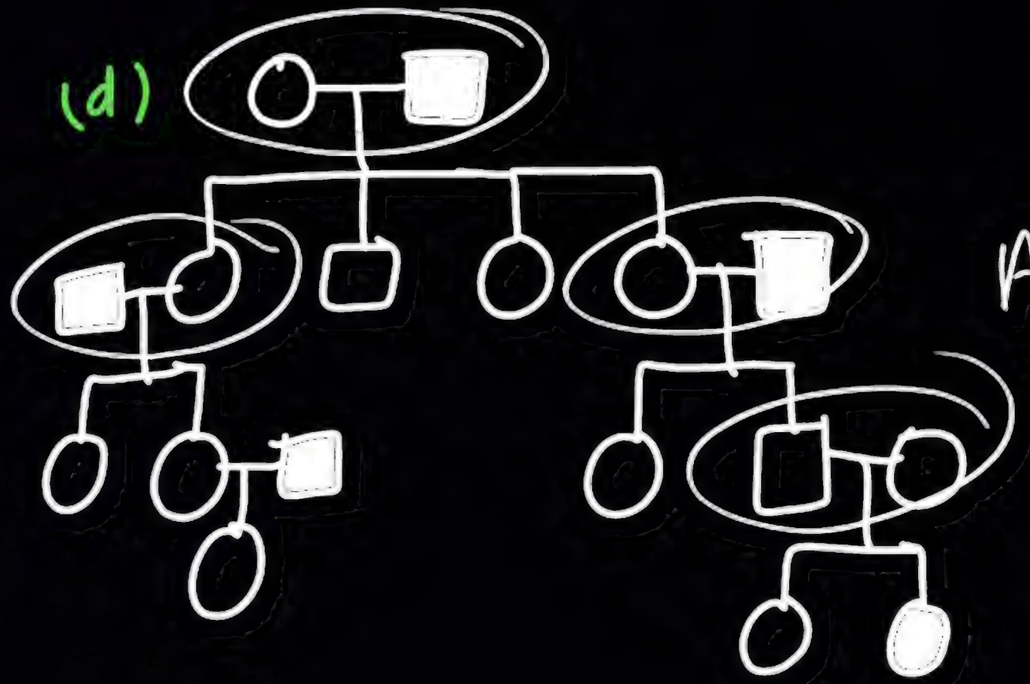
AR ✗
AD ✓

(c)



AR

(d)



ADX
AR ✓

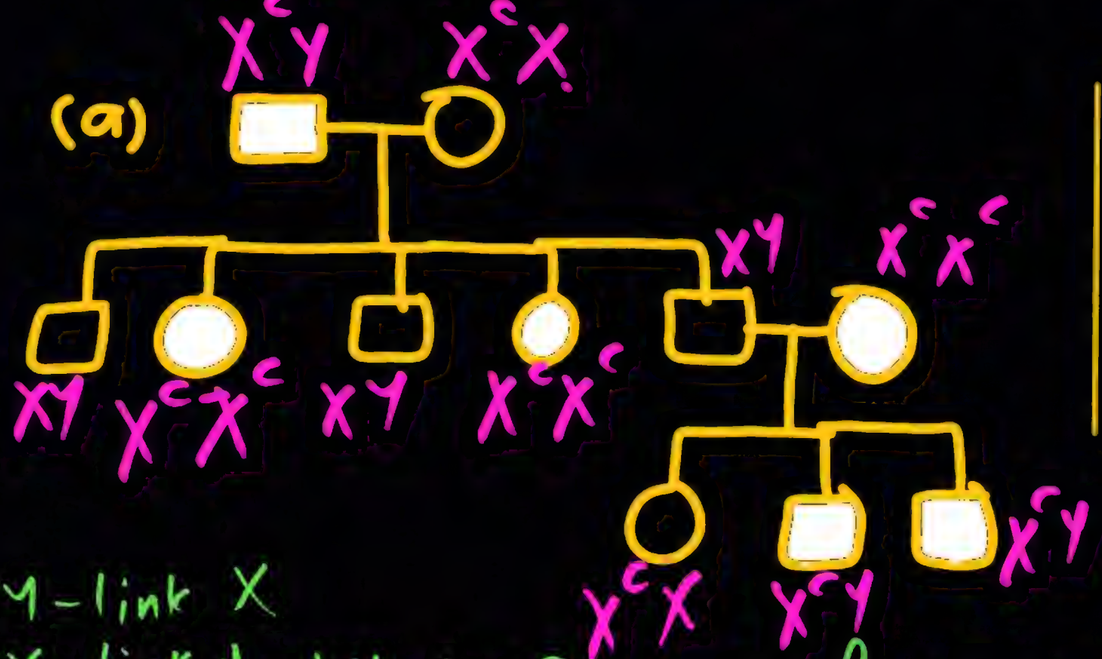
III Identify → (a) Sex linked or Colour Blindness

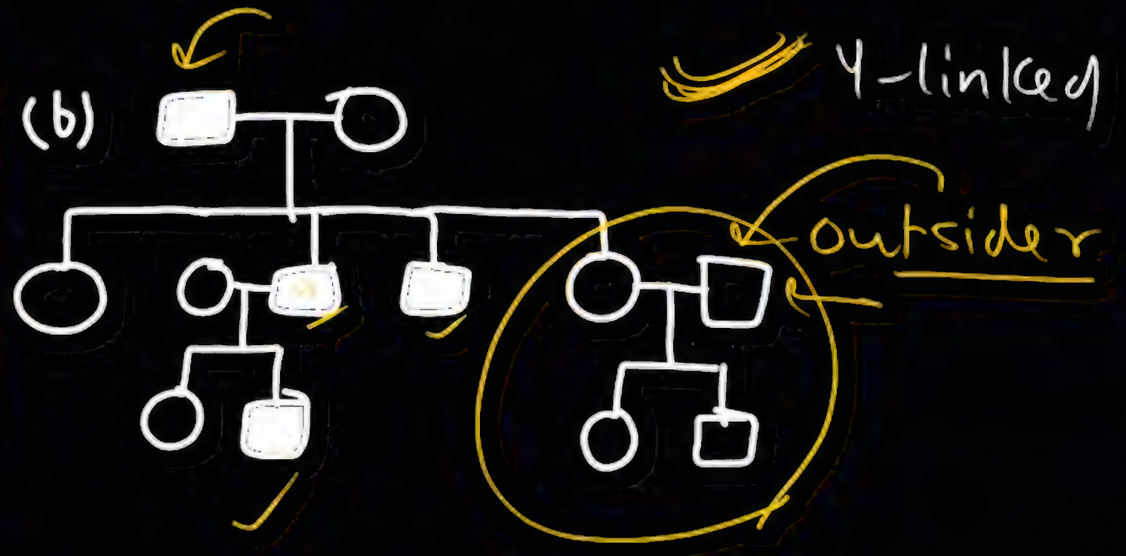
(b) Autosomal Recessive or SCA | Thallasmia

(c) Autosomal Dominant or Myotonic dystrophy

(d) Y-linked or TDF or Hypertrichosis

Y-link X





Y-link X

X-linked → Check → Disease Female → Father affected

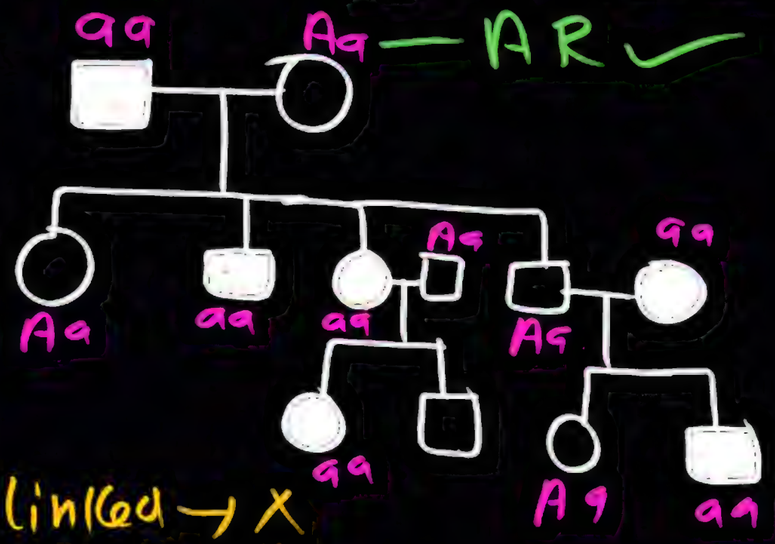
Disease Female - all Son Affected

III Identify → (a) Sex linked or Colour Blindness

(b) Autosomal Recessive or SCA

(c) Autosomal Dominant or Myotonic dystrophy

(d) Y-linked or TDF or Hypertrichosis

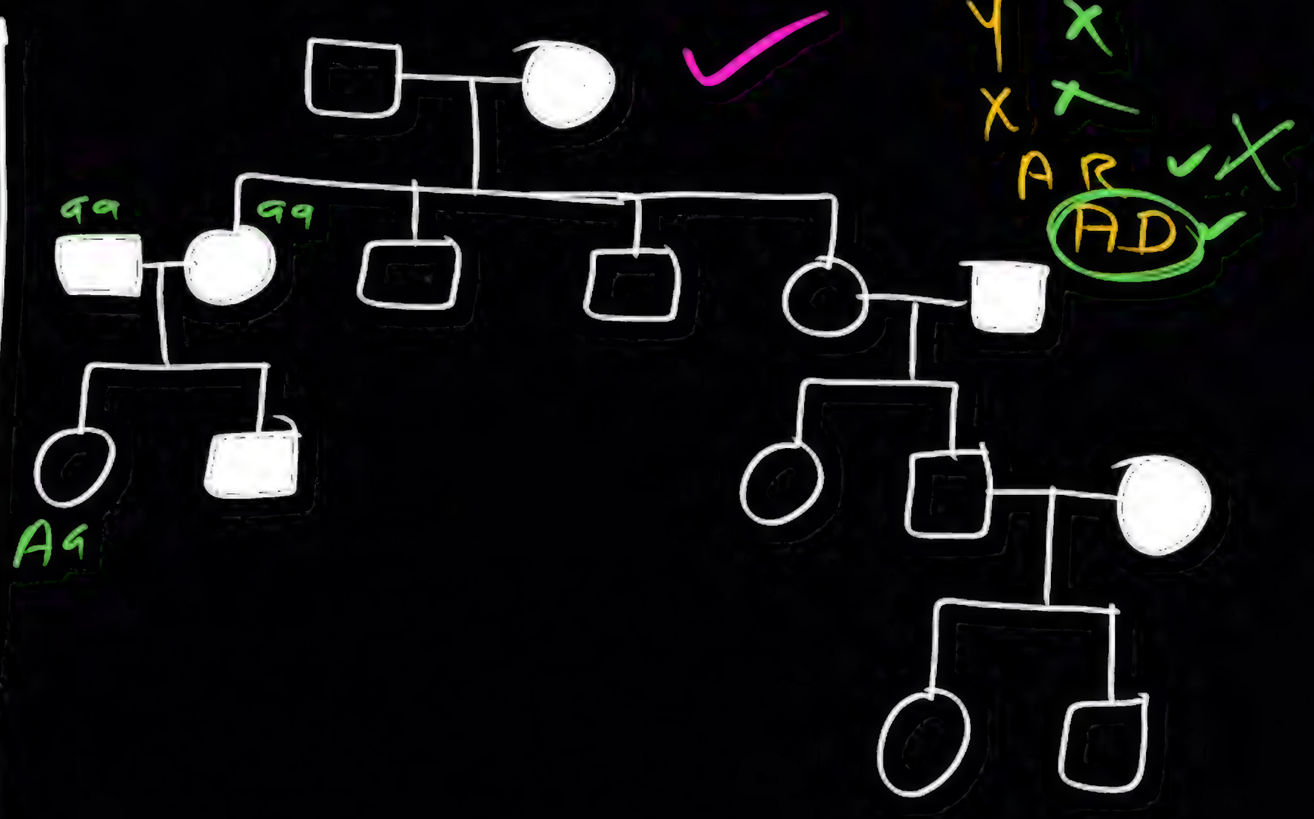


Y-linked → X

X-linked → X

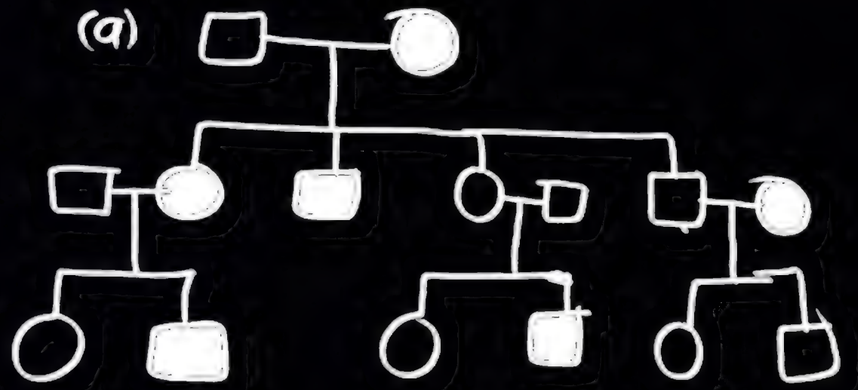
AR

AD

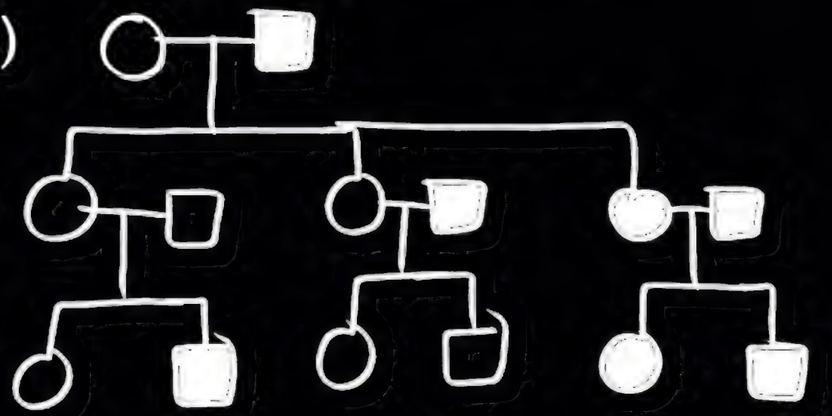


III Identify → (a) Sex linked or Colour Blindness
(b) Autosomal Recessive or SCA
(c) Autosomal Dominant or Myotonic dystrophy
(d) Y-linked or TDF or Hypertrichosis

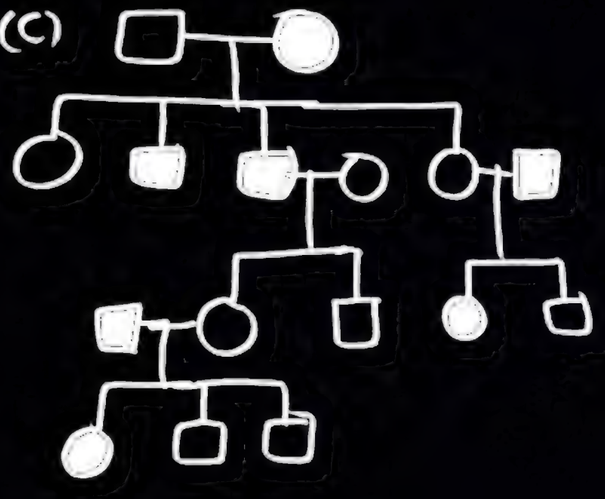
(a)



(b)



(c)



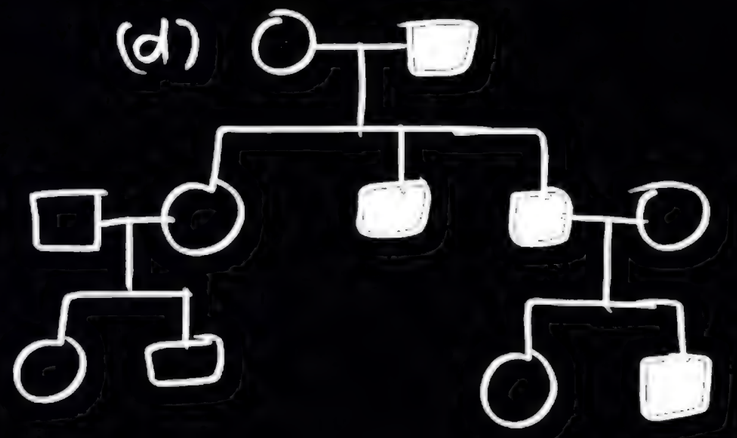
III Identify → (a) Sex linked or Colour Blindness

(b) Autosomal Recessive or SCA

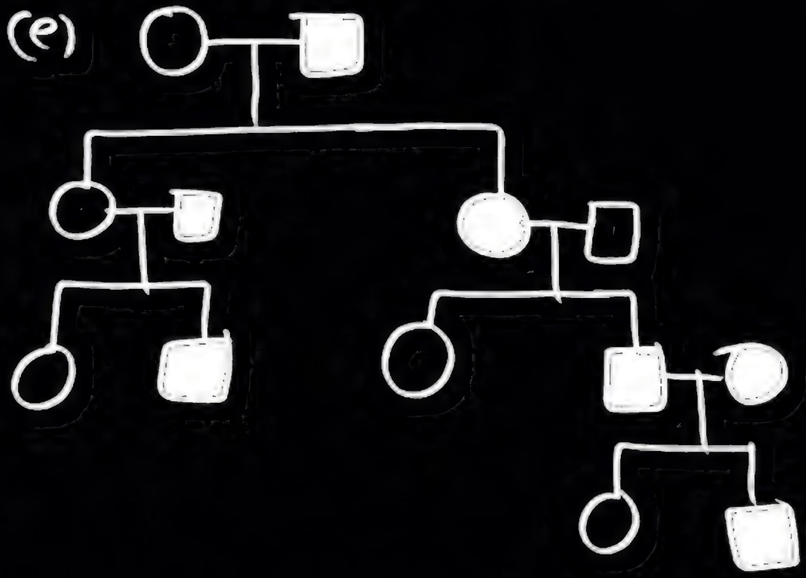
(c) Autosomal Dominant or Myotonic dystrophy

(d) Y-linked or TDF or Hypertrichosis

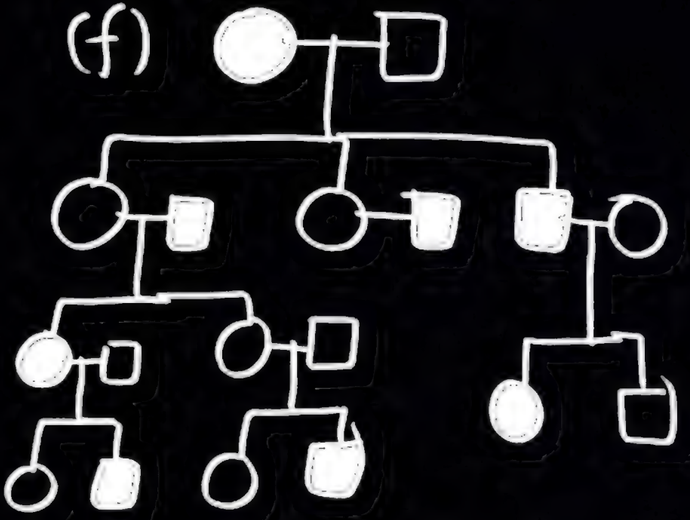
(d)



(e)



(f)



III Identify → (a) Sex linked or Colour Blindness

(b) Autosomal Recessive or SCA

(c) Autosomal Dominant or Myotonic dystrophy

(d) Y-linked or TDF or Hypertrichosis

Answer

(a) – AR

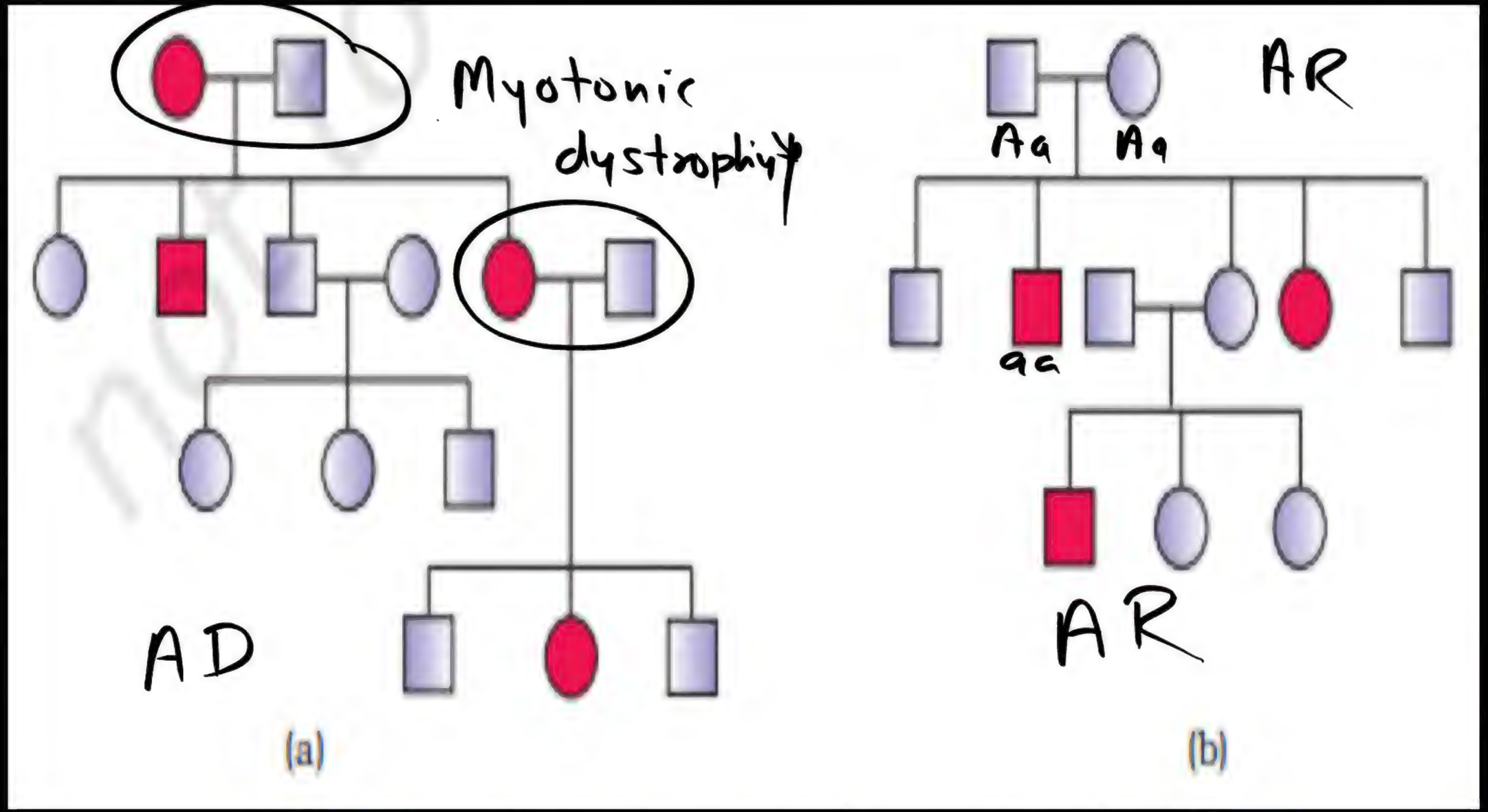
(b) AR

(c) X-linked

(d) Y-linked

(e) AD

(f) AR


Myotonic dystrophy
AD
(a)
AR
Aa
Aa
aa
AR
(b)

MANTHAN NEET 2025(1.0१२.0)

SANKALP NEET VEDANTU

principle of inheritance

lecture-13

Botany

TARUN SIR

Topics

introduction-gene,allele ,chromosome ,haploid,diploid

Mendelian principle- hybridisation experiment,result,law and cross

Gene interaction- incomplete dominance,co-dominance and muliple allele, polygenic inhritance

DOPA prime-1

Chromosomal theory, linkage and sex determination

Dopa prime -2

Mutation, pedigree analysis, genetic disroder

Dopa prime -3

Some important observation

- Genotype For → Autosomal — use → AA, Aa, aa
  → Sex linked, Y-linked XY
  XX, XY

- For Autosomal For male & Female we use genotype
- For Sex linked we use Genotype →

male → X^cY (Affected), XY (normal)

Recessive → X^cX (Affected)

XX, XX (Female)

→ Dominant (Disease) → Affected – Aa, AA
  normal → aa

→ Recessive → Affected → aa
  normal → Aa, AA

Q Myotonic dystrophy – incorrect

(a) Possible in male

(b) Possible in Female

(c) ~~XY~~ Aa
AA

(d) Aa, AA

Q Colour Blindness → (Sex linked Recessive)

(a) ♀ – XX (b) ♀ – X^cX^c (c) X^cX X^cY (d) ~~X^cX^c~~ X^cY

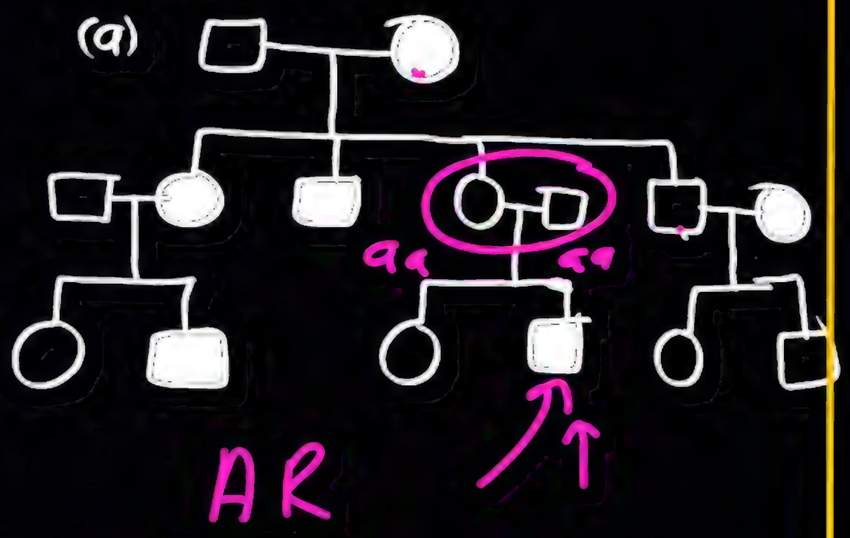
Q Sickle cell Anemia (A·R) in male

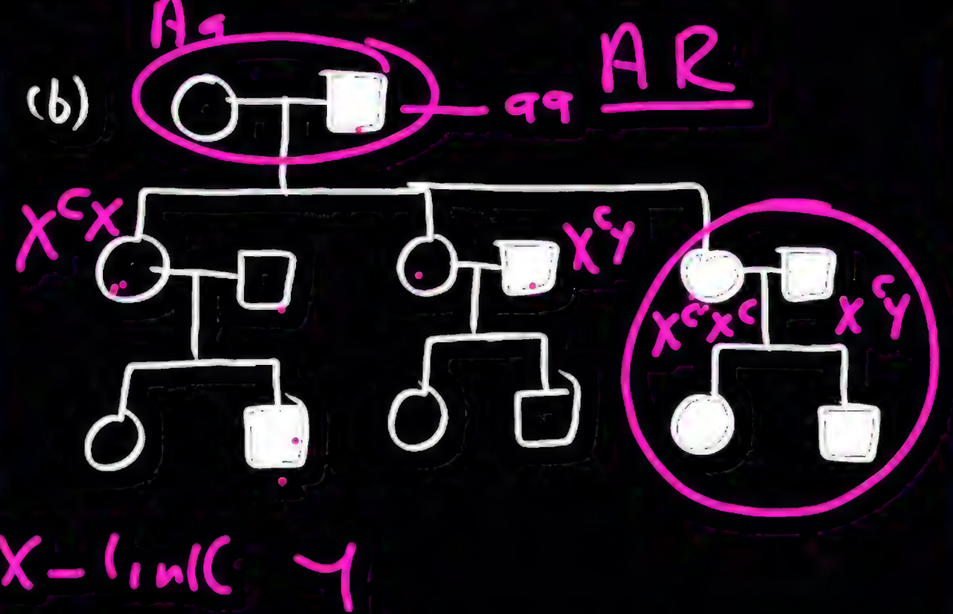
(a) ♀ – aa × ♂ – aa

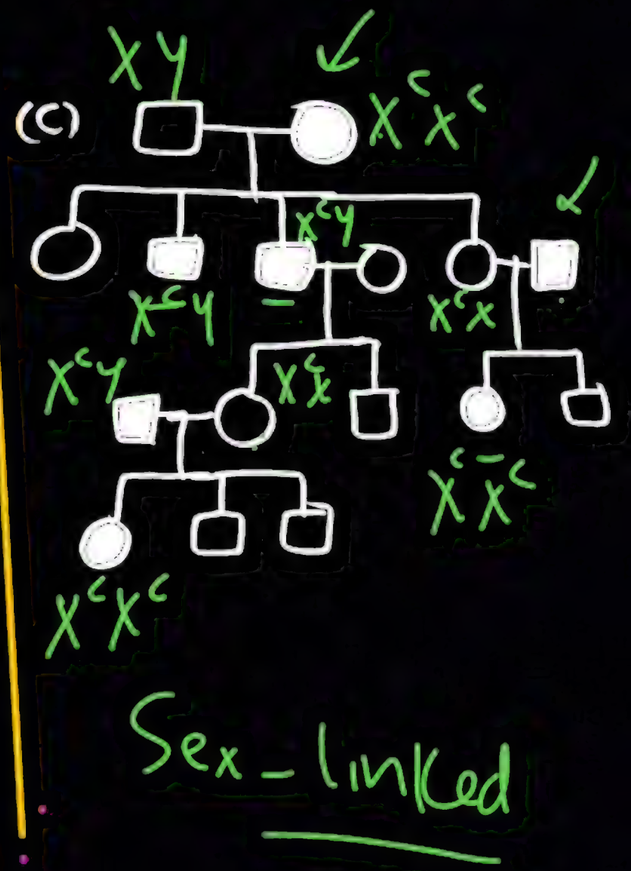
(b) Aa

(c) aa

III Identify → (a) Sex linked or Colour Blindness
(b) Autosomal Recessive or SCA
(c) Autosomal Dominant or Myotonic dystrophy
(d) Y-linked or TDF or Hypertrichosis



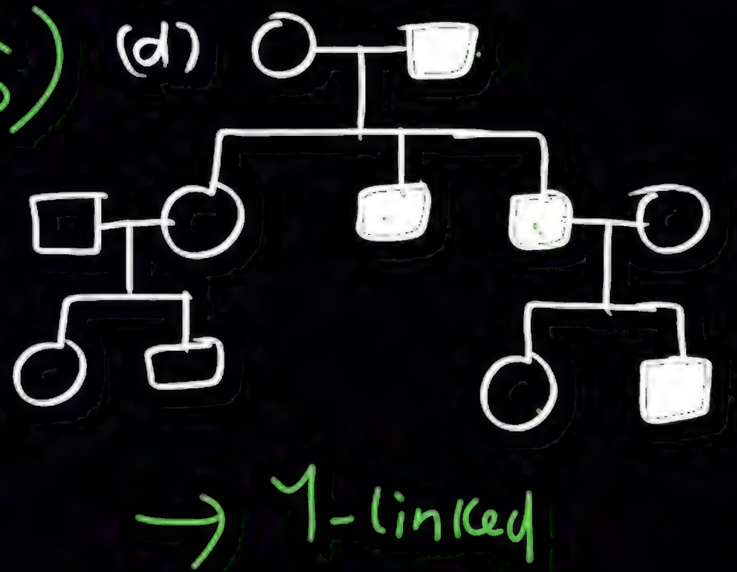


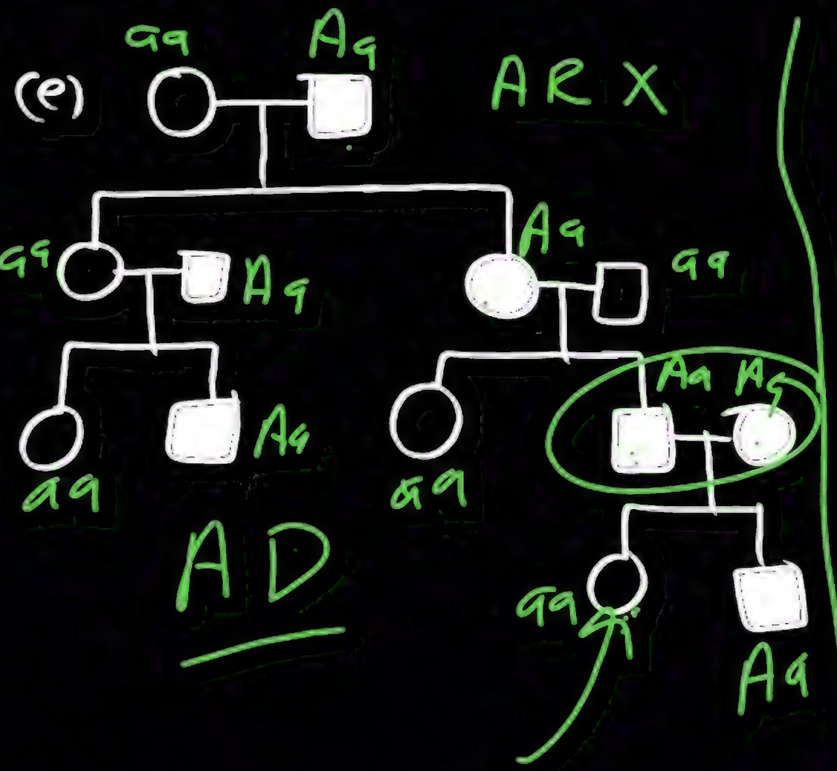


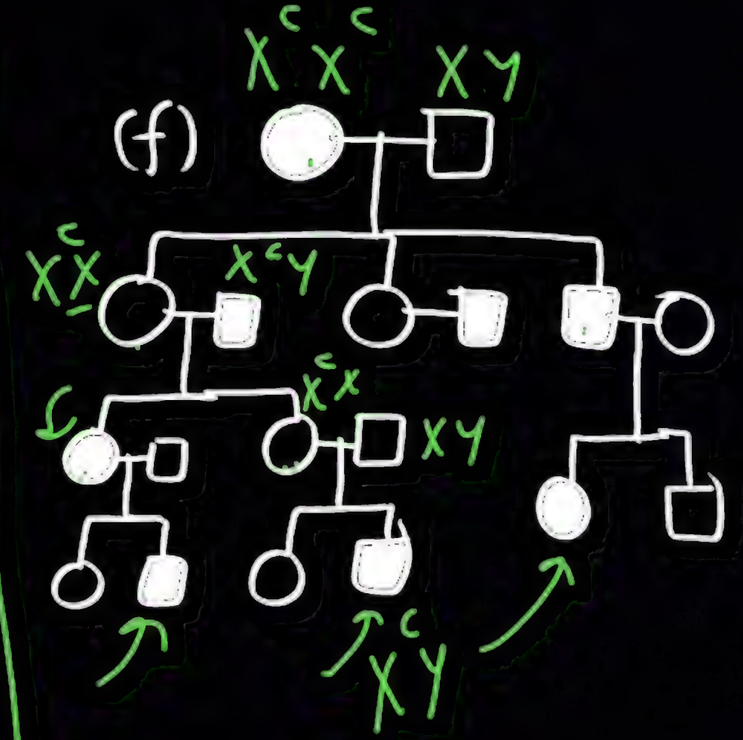
III Identify → (a) Sex linked or Colour Blindness
(b) Autosomal Recessive or SCA
(c) Autosomal Dominant or Myotonic dystrophy
(d) Y-linked or TDF or Hypertrichosis

Y → ✓
S ✓

A·R
A·D







Genetic Disorders → Can pass from parent to offspring - By gamete

Reason → Due to mutation in DNA – Germ cell → Pass on into progeny ✓

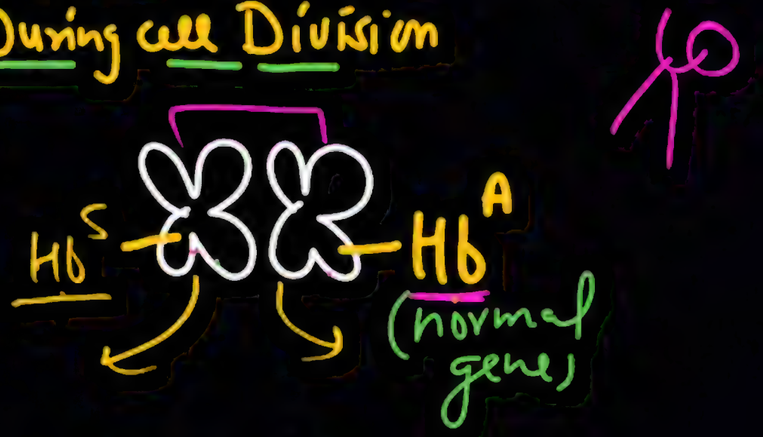
Due to change in chromosome structure & number → During cell Division

type →

① Mendelian – Due to point mutation ✓

– Follow mendelian Pattern of inheritance

– Can be Draw on pedigree ✓



Chromosomal → Due to Abnormality in Structure & number of Chromosome

47 chromosome → Randomly Form During cell Division

→ not possible on pedigree

Ex - Down's Syndrome

Cri du cat Syndrome

(Chr-5 → Part missing)

→ gametes (Sperm)

Spermatogia → 24 Chromosome

(Aneuploidy) 22 Chromosome

Chromosomal Disorders

→ Chromosome number & Structure get change

→ Entire copy of Genome Extra ⟶ Polyploidy (viable in plants, not in Animals)

2n = 46 Human ↓ 3n → Human ✗

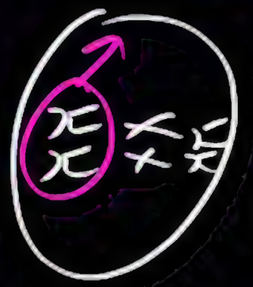
→ Aneuophoidy → Increase or decrease of chromosome(s)

Reason - During Meiosis ⟶ Anaphase I ⟶ Disjunction occur - normal process

(Pair of chromosomes seperate)

But due to non-Disjunction

Pair not Segregate ⟶ Complete pair move to pole



- Due to which gametes with Inc. or dec. → number of chromosome)

Condition - when individual more or less chromosome(s) — Aneuploidy

Ex - ① Down's syndrome
② Klinefelter's Syndrome
③ Turner's Syndrome

I

Down's Syndrome → 47 chromosome, 21st chromosome trisomy (23 + 24) or (Reverse)

(Sperm + Ovum)

1866 langdon down observe

(47)

Symptoms → (1) open mouth (6) Pschcomotor (mentally Retarted)

(3) low IQ (4) Distinct palm crease, Fingers loop, (5) Flat Fore head

(6) Round Face (7) Congenital Heart Disease

(8) Furrow tongue

Barr Body + total X − 1 → normal Female 1 Barr body

Other Example of trisomy

Patau's → 13 — P — 13

Edward → 18 — E — 18

Down's → 21 Extra — D — 21

II Klinefelter's Syndrome → 44 + XXY → male with Extra X-chromosome (not trisomy)

(47)

Symptoms – Male with Feminine character

– Gynaecomastia (Breast development)

– Sterile

III Turner's Syndrome → 44 + XO → Female, one X-chromosome less

→ Ovary – Rudimentary (not well developed)

(45)

(Zero barr Body) → Sterile, Short stature

Extra

Supermale – 44 + XYY

Superfemale – 44 + XXX

(Barr body + 2)

Down's Syndrome : The cause of this genetic disorder is the presence of an additional copy of the chromosome number 21 (trisomy of 21). This disorder was first described by Langdon Down (1866). The affected individual is short statured with small round head, furrowed tongue and partially open mouth (Figure 5.16). Palm is broad with characteristic palm crease. Physical, psychomotor and mental development is retarded.

Klinefelter's Syndrome : This genetic disorder is also caused due to the presence of an additional copy of X-chromosome resulting into a karyotype of 47, XXY. Such an individual has overall masculine development , however, the feminine development (development of breast, i.e., Gynaecomastia) is also expressed (Figure 5.17 a). Such individuals are sterile.

Turner's Syndrome : Such a disorder is caused due to the absence of one of the X chromosomes, i.e., 45 with XO. Such females are sterile as ovaries are rudimentary besides other features including lack of other secondary sexual characters (Figure 5.17 b).

5.6.3 Chromosomal disorders

The chromosomal disorders on the other hand are caused due to absence or excess or abnormal arrangement of one or more chromosomes.

Failure of segregation of chromatids during cell division cycle results in the gain or loss of a chromosome(s), called **aneuploidy**. For example, Down's syndrome results in the gain of extra copy of chromosome 21. Similarly, Turner's syndrome results due to loss of an X chromosome in human females. Failure of cytokinesis after telophase stage of cell division results in an increase in a whole set of chromosomes in an organism and,

Mendelian Disorders

Autosomal Dominant

- Myotonic dystrophy

Mention in NCERT

Autosomal Recessive

- Sickle cell Anaemia ✓
- Thallesimia ✓
- PKU ✓

in detail

- Cystic Fibrosis
- Muscular dystrophy
- Albinism
- Galactosemia
- Tay sach's disease
- Gaucher's disease

sex linked Recessive

- Haemophilia
- Colour Blindness

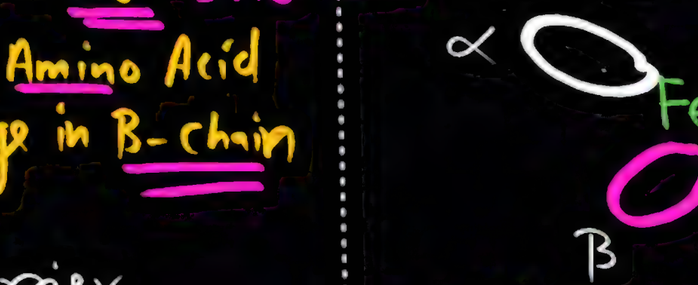
Sickle cell Anemia

→ Autosomal Recessive Disorder

Hb → Haemoglobin
Hb^A → normal Hb^S → Abnormal

Reason → Point mutation in Gene → Hb^A → Hb^S Form
(Substitution occur → one Amino Acid change in β-chain)

Adult Haemoglobin :-



Hb^A → normal β-chain
Hb^S → Abnormal β-chain

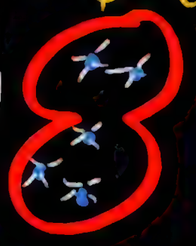
Hb^A – normal allele
Hb^S → Mutant allele

→ Sickle cell Anaemia Appear
When → Marriage B/w two carrier

$Hb^A Hb^S$ × $Hb^A Hb^S$

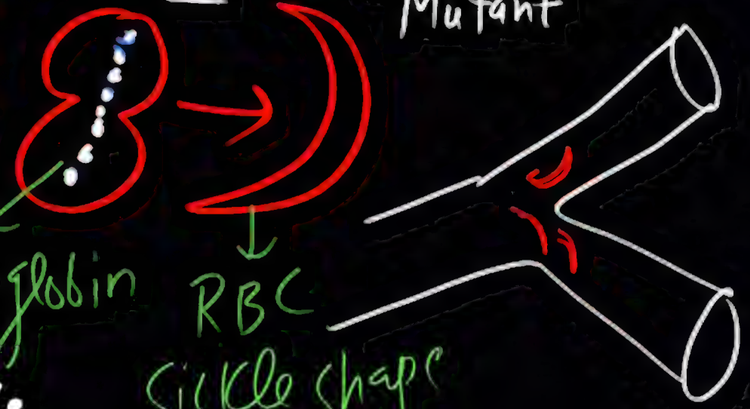
$Hb^A Hb^A$	$Hb^A Hb^S$	$Hb^A Hb^S$	$Hb^S Hb^S$
(normal)	(carrier (so!) (normal)		Affected

① $Hb^A Hb^A$ – Both Allele normal →



② $Hb^A Hb^S$ → (carrier (one Affected allele)

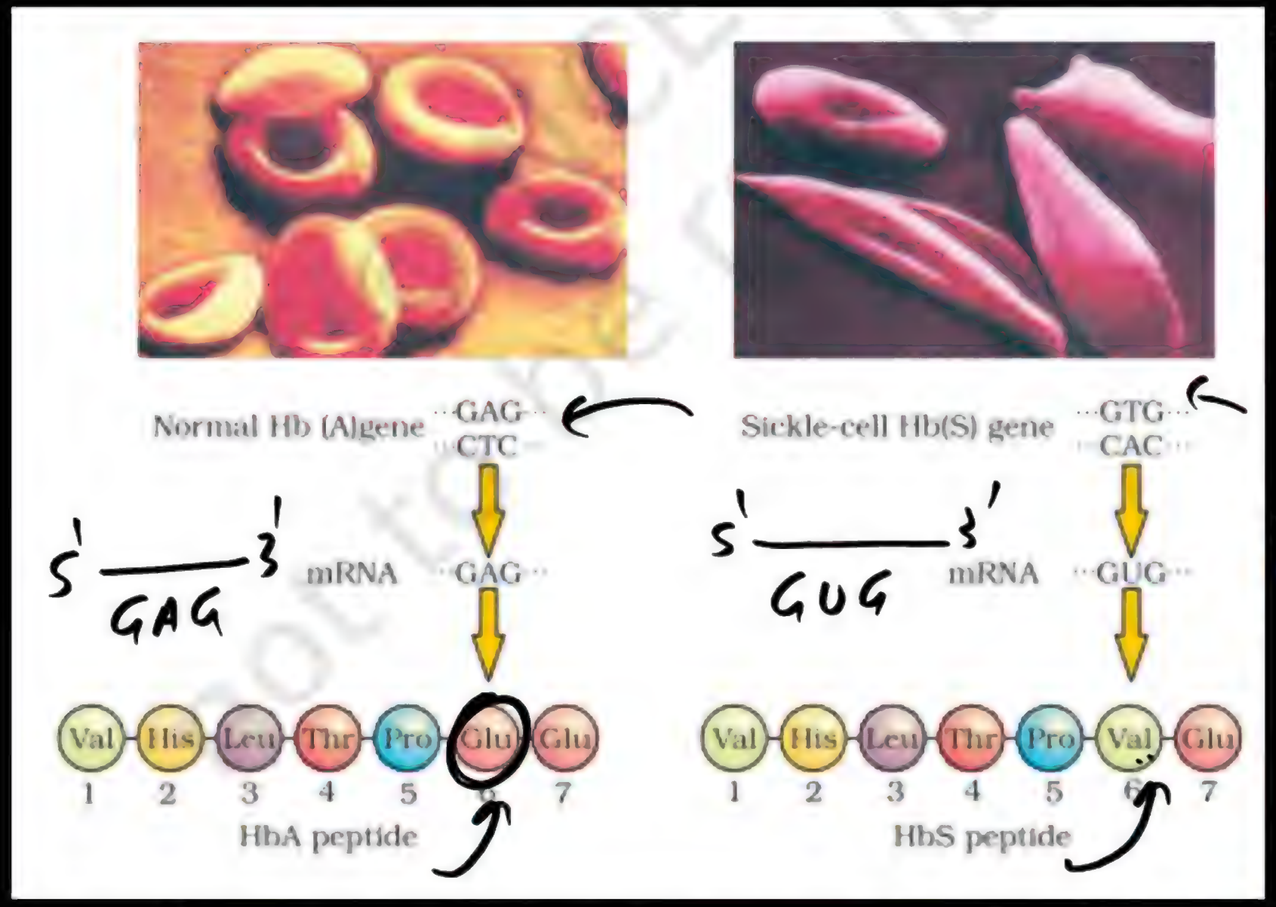
③ Affected
$Hb^S Hb^S$ (Both allele Mutant



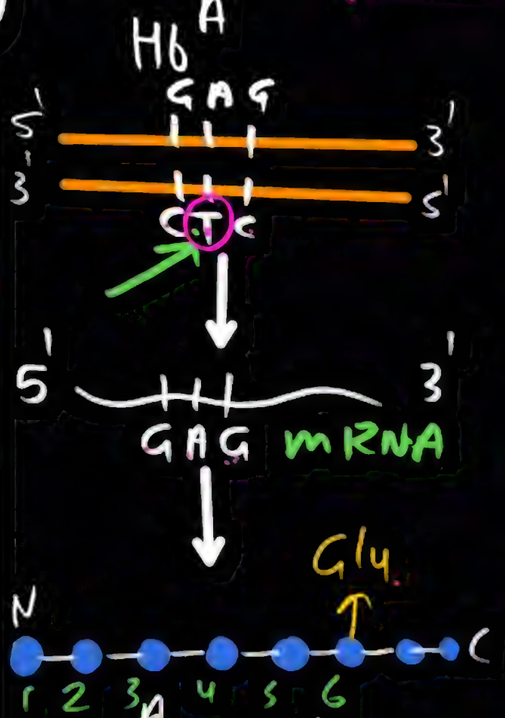
Haemoglobin Polymerise

RBC Sickle shape

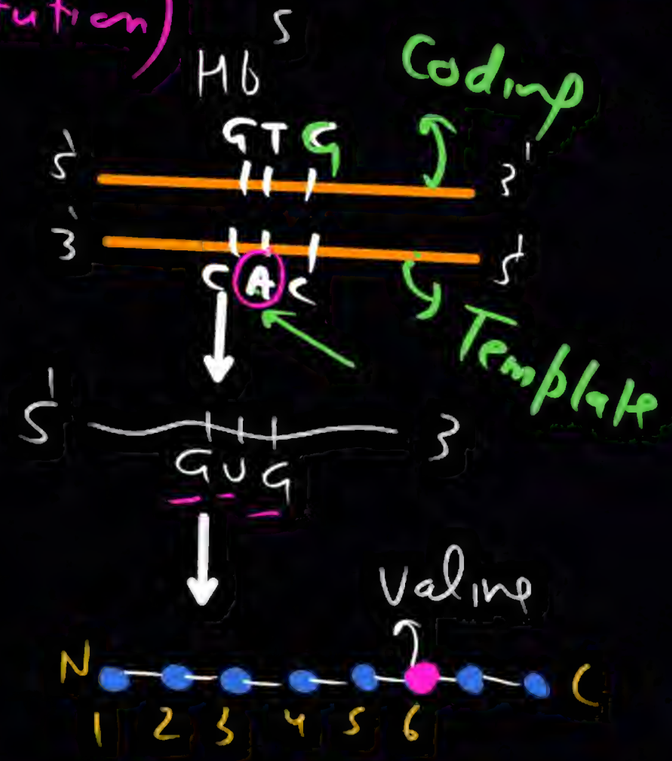
Symptons – RBC → Sickle shape (Block in capillaries)
→ Blood supply dec → O_2 dec. (Severe pain)
→ RBC destroy Early (Anaemia occur)



Point mutation
(Substitution)



Hb peptide
(β-chain)
6th – Glutamic Acid



Abnormal
β-chain
(Valine – 6th position)

the gene has a 50 per cent chance of being colour blind. The mother is not herself colour blind because the gene is recessive. That means that its effect is suppressed by her matching dominant normal gene. A daughter will not normally be colour blind, unless her mother is a carrier and her father is colour blind.

Haemophilia : This sex linked recessive disease, which shows its transmission from unaffected carrier female to some of the male progeny has been widely studied. In this disease, a single protein that is a part of the cascade of proteins involved in the clotting of blood is affected. Due to this, in an affected individual a simple cut will result in non-stop bleeding. The heterozygous female (carrier) for haemophilia may transmit the disease to sons. The possibility of a female becoming a haemophilic is extremely rare because mother of such a female has to be at least carrier and the father should be haemophilic (unviable in the later stage of life). The family pedigree of Queen Victoria shows a number of haemophilic descendents as she was a carrier of the disease.

Sickle-cell anaemia : This is an autosome linked recessive trait that can be transmitted from parents to the offspring when both the partners are carrier for the gene (or heterozygous). The disease is controlled by a single pair of allele, Hb^A and Hb^S. Out of the three possible genotypes only homozygous individuals for Hb^S (Hb^SHb^S) show the diseased phenotype. Heterozygous (Hb^AHb^S) individuals appear apparently unaffected but they are carrier of the disease as there is 50 per cent probability of transmission of the mutant gene to the progeny, thus exhibiting sickle cell trait (Figure 4.15). The defect is caused by the substitution of Glutamic acid

Sickle is an autosome linked recessive trait that can be trai s to the offspring when both the partners are carrier ozygous). The disease is controlled by a single pair o . Out of the three possible genotypes only homoz Hb^S (Hb^SHb^S) show the diseased phenotype. Heterozygous (Hb^AHb^S) individuals appear apparently unaffected but they are carrier of the disease as there is 50 per cent probability of transmission of the mutant gene to the progeny, thus exhibiting sickle-cell trait (Figure 5.15). The defect is caused by the substitution of Glutamic acid (Glu) by

Valine (Val) at the sixth position of the beta globin chain of the haemoglobin molecule. The substitution of amino acid in the globin protein results due to the single base substitution at the sixth codon of the beta globin gene from GAG to GUG. The mutant haemoglobin molecule undergoes polymerisation under low oxygen tension causing the change in the shape of the RBC from biconcave disc to elongated sickle like structure (Figure 5.15).

as she was a carrier of the disease.

Sickle-cell anaemia : This is an autosome linked recessive trait that can be transmitted from parents to the offspring when both the partners are carrier for the gene (or heterozygous). The disease is controlled by a single pair of allele, Hb^A and Hb^S. Out of the three possible genotypes only homozygous individuals for Hb^S (Hb^SHb^S) show the diseased phenotype. Heterozygous (Hb^AHb^S) individuals appear apparently unaffected but they are carrier of the disease as there is 50 per cent probability of transmission of the mutant gene to the progeny, thus exhibiting sickle-cell trait (Figure 4.15). The defect is caused by the substitution of Glutamic acid

Thallasemia

→ Autosomal Recessive Disease

→ Sickle cell Anaemia → β-chain (Abnormal) —— thallasemia → less Synthesis α-chain or β-chain

Adult Haemoglobin
2 α chain ✓
2 β-chain ✓

Chr-11
Gene For β-chain

HBB —— HBB → β-chain

Gene For α-chain

HBA1 —— HBA1 → α-chain
HBA2 —— HBA2 → α-chain

Chr-16

→ α & β chain → total 3 locus, 6 allele

→ β-chain → 1 locus → chromosome 11 (2 allele)

→ α-chain → 2 locus → chromosome-16 (Closely linked) (4 allele)

thallasemia → less α

SCA

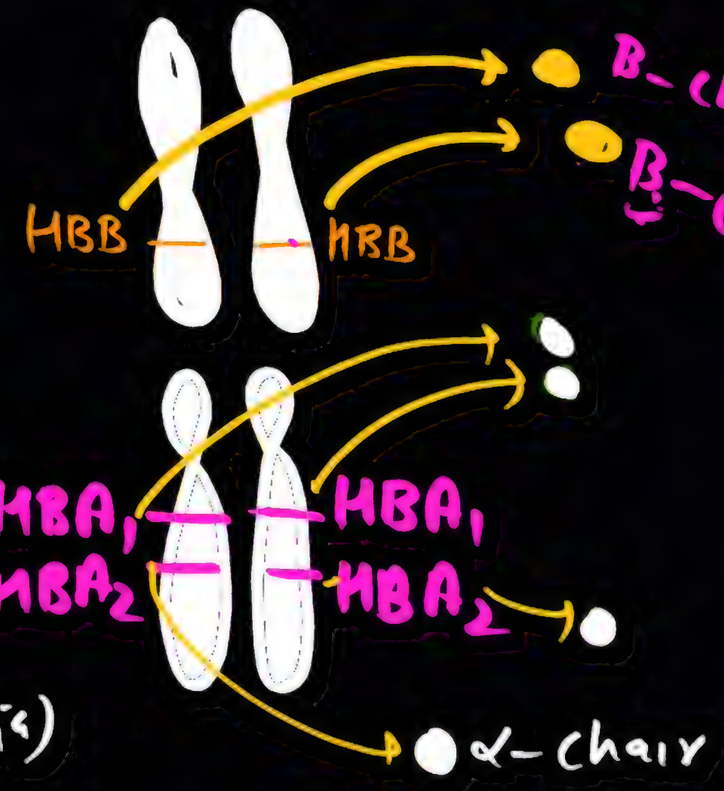
β-chain (Abnormal

Genotype

- HBB HBB (normal) ⟶ B-chain
- HBB HBB (mutant) ⟶ less B-chain ✓ (Still Sufficient) } B-thallesimia minor
- HBB HBB ⟶ very less B-chain } B-thallesimia major

[Genotype for α-chain ⟶ total locus → 2, total allele = 4

(1 mutation → no Effect
2 mutation → minor
3 mutation → sufficient Effect (α-thallesimia)



Sickle cell Anaemia

→ Abnormal B-chain
→ HB^AHB^A or HB^AHB^S } Same phenotype

Qualitative inheritance

thallesimia

- less α-chain & less B-chain
= number of normal allele → Effect

- Quantitative inheritance

MANTHAN NEET 2025(1.0 to 2.0)

SANKALP NEET VEDANTU

principle of inheritance

lecture- 14

Botany

TARUN SIR

Topics

introduction-gene,allele ,chromosome ,haploid,diploid

Mendelian principle- hybridisation experiment,result,law and cross

Gene interaction- incomplete dominance,co-dominance and muliple allele, polygenic inhritance

DOPA prime-1

Chromosomal theory, linkage and sex determination

Dopa prime -2

Mutation, pedigree analysis, genetic disroder

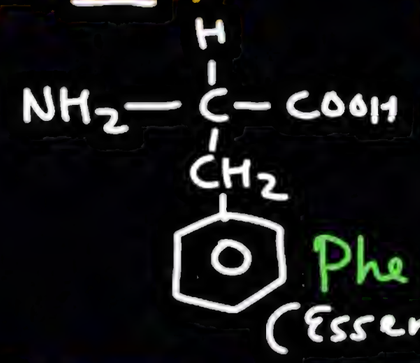
Dopa prime -3

Phenyl ketone urea

– Autosomal Recessive

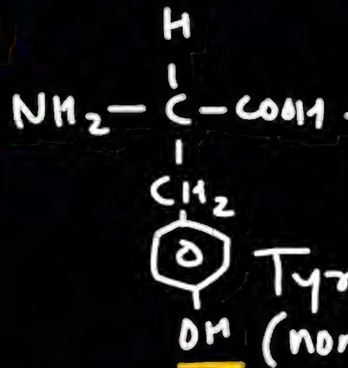
AA – normal
Aa → normal (Carrier)
aa – PKU (Affected)

– Inborn disease of Metabolism → By Birth Enzyme Absent
(By Birth)



Phe
(Essential)

Phenyl alanine Hydroxylase →



Tyrosine
(non-Essential)

→ Melanine (Skin, hair Eye)
→ T_3 & T_4
→ Dopamine
→ Adrenaline

In PKU → Hydroxylase Absent By Birth

→ Phe ↑ —Liver deamination→ Phenyl Pyruvate (Ketone body)
→ Poor Absorption in Kidney (Re) Come in Urine
→ Accumulate in Brain (Mental Retardation)

→ Tyr ↓ → less Synthesis Of Melanine → dec. in Hair & Skin pigmentation)

Phenylketonuria : This inborn error of metabolism is also inherited as the autosomal recessive trait. The affected individual lacks an enzyme that converts the amino acid phenylalanine into tyrosine. As a result of this phenylalanine is accumulated and converted into phenylpyruvic acid and other derivatives. Accumulation of these in brain results in mental retardation. These are also excreted through urine because of its poor absorption by kidney.

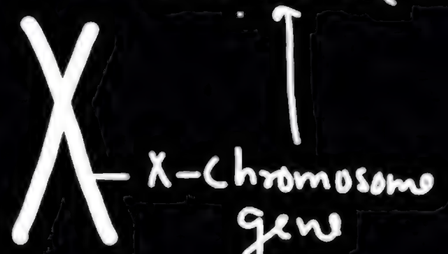
Colour Blindness (Ishihara test)

Disease – Sex linked | X-linked Recessive — present on X-chromosome

Reason – Mutation in Gene of cone cells (Red or Green cone cell problem)

(Person not Able to Distinguish B/w Red & Green)

Retina → Rod cell
→ Cone cell (Colour Distinction)



male → normal – XY

Colour Blind → X^cY

Female → XX normal

X^cX – Carrier (normal)

X^cX^c → Colour Blind Female

* If Female colour Blind → all male child Colour Blind

* Daughter colour Blind → Father colour Blind & Mother atleast Carrier

* Since male → only one X-Chromosome → More Chance to Show Colour Blindness

Colour Blindness observed →
- 8% male
- 0.4% Female

Case I

$X^cX \cdot X^cY$

Mother (Carrier) — Colour Blind (Father)

X^cX^c — Colour Blind Female

X^cY — Colour Blind male

XX^c — normal (Carrier)

XY — normal

Progeny → Colour Blind → 50%.

Male Affected → 50% male Colour Blind

Female affected → 50%.

Case-II

$X^cX - XY$

Carrier — normal

X^cX — normal (Carrier)

XX — normal

X^cY — Colour Blind

XY — normal

Progeny → 25% → $\frac{1}{4}$ ✓

Male → 50%

Female affected → Zero

$X^cX^c - XY$

X^cX X^cX X^cY X^cY

Colour Blind → male → 100% ✓

Colour Blind Female → 0% ✓

Progeny Colour Blind → 50%

Haemophilia — Bleeder's Disease

Blood Clotting → 13 Factor Require
(Any Factor Absent → Clotting time ↑ Inc.)

- Haemophilia → X-linked Recessive (X-chromosome
  Factor VIII – Antihaemophilic Factor
  Factor IX – Christmas Factor

mutation → Factor VIII gene – Haemophilia A
(most common)

Mutation – Factor IX gene – Haemophilia B

In Haemophilia some protein which is part of Cascade of Blood Clotting Absent (Clotting time Increase)

normal cross → Carrier X^hX Female × normal male XY

X^hX XX X^hY XY

Genotype

XX – normal Female

X^hX – Carrier (normal)

X^hX^h → affected

XY – normal

X^hY → haemophilic (Unviable in later stage)

* Female is Affected when → Father is haemophilic & mother carrier
(Rare) (Unviable)

* First time observed in → Royal Family of England
(Queen – Carrier) → Some son haemophilic)

Q1 Normal Female with haemophilic trait marries to normal man, % age of child with haemophilia
(a) Zero (b) 50% (c) 25% (d) 100%

$X X^h \cdot XY$

$\downarrow$

$XX \quad XY \quad X^hX \quad X^hY$

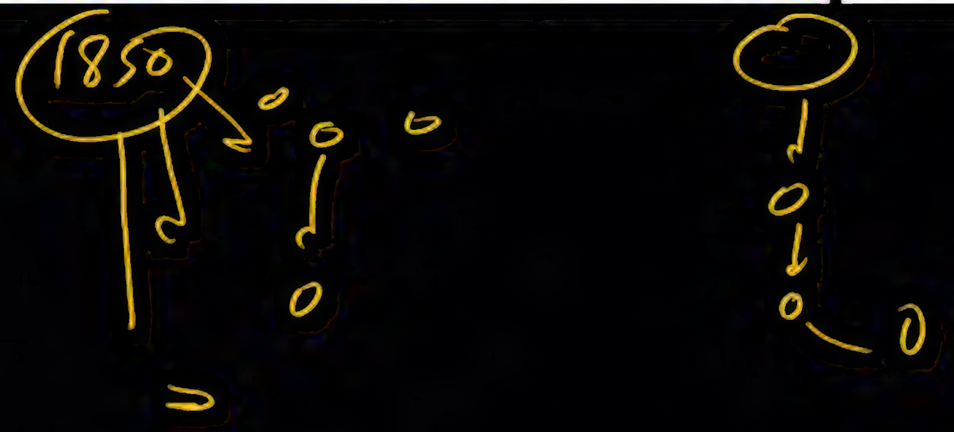
Q1 Normal Female (Father Colour Blind) Marries to Colour Blind male
% of Child colour Blind
(a) Zero (b) 50% (c) 25% (d) 100

$X^cX \cdot X^cY$

$\downarrow$

$X^cX^c \quad X^cY \quad XX^c \quad XY$

Haemophilia : This sex linked recessive disease, which shows its transmission from unaffected carrier female to some of the male progeny has been widely studied. In this disease, a single protein that is a part of the cascade of proteins involved in the clotting of blood is affected. Due to this, in an affected individual a simple cut will result in non-stop bleeding. The heterozygous female (carrier) for haemophilia may transmit the disease to sons. The possibility of a female becoming a haemophilic is extremely rare because mother of such a female has to be at least carrier and the father should be haemophilic (unviable in the later stage of life). The family pedigree of Queen Victoria shows a number of haemophilic descendents as she was a carrier of the disease.



Thalassemia : This is also an autosome-linked recessive blood disease transmitted from parents to the offspring when both the partners are unaffected carrier for the gene (or heterozygous). The defect could be due to either mutation or deletion which ultimately results in reduced rate of synthesis of one of the globin chains (α and β chains) that make up haemoglobin. This causes the formation of abnormal haemoglobin molecules resulting into anaemia which is characteristic of the disease. Thalassemia can be classified according to which chain of the haemoglobin molecule is affected. In α Thalassemia, production of α globin chain is affected while in β Thalassemia, production of β globin chain is affected. α Thalassemia is controlled by two closely linked genes HBA1 and HBA2 on chromosome 16 of each parent and it is observed due to mutation or deletion of one or more of the four genes. The more genes affected, the less alpha globin molecules produced. While β Thalassemia is controlled by a single gene HBB on chromosome 11 of each parent and occurs due to mutation of one or both the genes. Thalassemia differs from sickle-cell anaemia in that the former is a quantitative problem of synthesising too few globin molecules while the latter is a qualitative problem of synthesising an incorrectly functioning globin.

Q 1

Identify the wrong statement with reference to the gene 'I' that controls ABO blood groups. (2020)

(A) A person will have only two of the three alleles.

(B) When IA and IB are present together, they express same type of sugar.

(C) Allele 'i' does not produce any sugar

(D) The gene (I) has three alleles

Q 2

Experimental verification of the chromosomal theory of inheritance was done by: (2020)

(A) Sutton

(B) Boveri

(C) Morgan

(D) Mendel

Q 3 Select the correct match (2020)

Column – I	Column - II
(A) Phenylketonuria	Autosomal dominant trait
(B) Sickle cell anaemia	Autosomal recessive trait chromosome-11
(C) Thalassemia	X linked
(D) Haemophilia	Y linked

Q 4

How many true breeding pea plant varieties did Mendel select as pairs, which were similar except in one character with contrasting traits? (2020)

(A) 2

(B) 14

(C) 8

(D) 4

Q 5

Chromosomal theory of inheritance was proposed by: (2020 Covid Re-NEET)

(A) Bateson and Punnet

(B) T.H. Morgan

(C) Watson and Crick

(D) Sutton and Boveri

Q 6

The number of contrasting characters studied by Mendel for his experiments was: (2020 Covid Re-NEET)

(A) 4

(B) 2

(C) 7

(D) 14

Q 7

The best example for pleiotropy is (2020 Covid Re-NEET)

(A) Phenylketonuria

(B) Colour Blindness

(C) ABO Blood group

(D) Skin colour

Q 8

What map unit (Centimorgan) is adopted in the construction of genetic maps? (2019)

(A) A unit of distance between two expressed genes representing 10% cross over.

1% R → 1 map unit → 1 cM → 1%

(B) A unit of distance between two expressed genes representing 100% cross over.

(C) A unit of distance between genes on chromosomes, representing 1% cross over.

(D) A unit of distance between genes on chromosomes, representing 50% cross over

Q 9

What is the genetic disorder in which an individual has an overall masculine development gynecomastia, and is sterile? (2019)

(A) Turner's syndrome

(B) Klinefelter's syndrome

(C) Edward syndrome

(D) Down's syndrome

Q 10

The frequency of recombination between gene pairs on the same chromosome as a measure of the distance between genes was explained by (2019)

(A) T.H. Morgan

(B) Gregor J. Mendel

(C) Alfred Sturtevant

(D) Sutton Boveri

Q 11

In Antirrhinum (Snapdragon) a red flower was crossed with a white flower and in F_1 generation pink flowers were obtained. When pink flowers were selfed, the F_2 generation showed white, red and pink flowers. Choose the incorrect statement from the following: (2019)

(A) This experiment does not follow the principle of dominance.

(B) Pink colour in F_1 is due to incomplete dominance.

(C) Ratio of F2 is 1/2 (Red) : 2/4 (Pink) :1/4 (White)

(D) Law of segregation does not apply in this experiment

Red X white
↓
Pink

Q 12

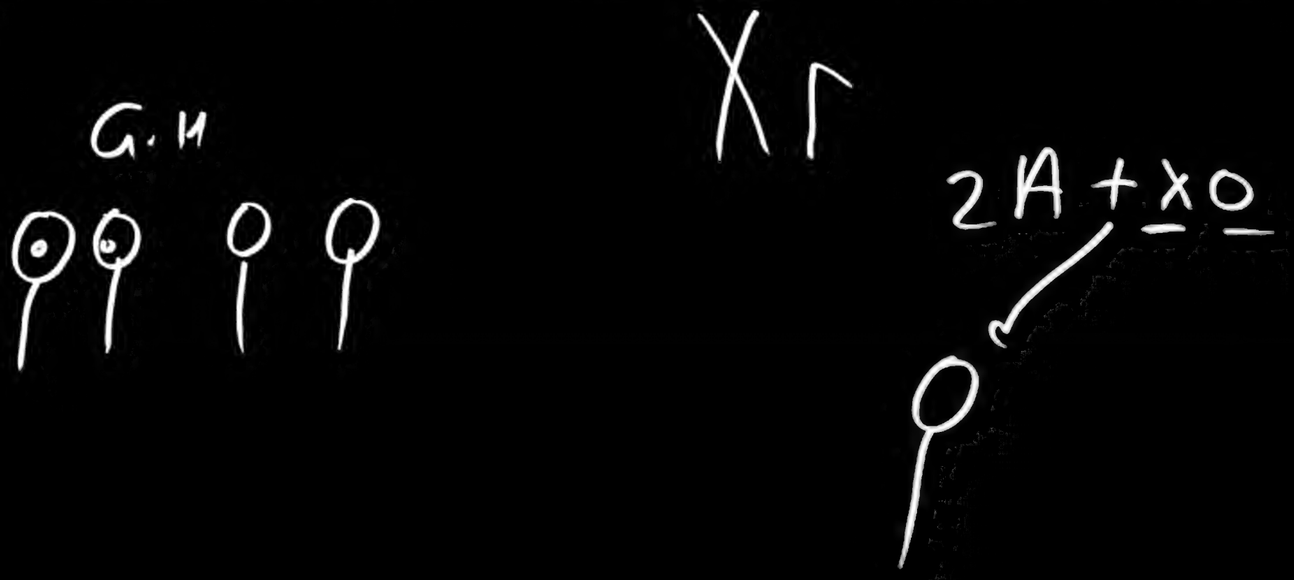
Select the incorrect statement. (2019)

(A) Male fruit fly is heterogametic XY

(B) In male grasshoppers 50% of sperms have no sex-chromosome So – X 50

(C) In domesticated fowls, sex of progeny depends on the type of sperm rather than egg ZZ ZW

(D) Human males have one of their sex-chromosome much shorter than the other



Q 13

Select the correct statement: (2018)

(A) Franklin Stahl coined the term "linkage".

(B) Punnett square was developed by a British scientist.

(C) Spliceosomes take part in translation.

(D) Transduction was discovered by S. Altman

Q 14 Which of the following pairs is wrongly matched? (2018)

(A) Starch synthesis in pea : Multiple alleles (Pleiotropy)

(B) ABO blood grouping : Co-dominance ✓

(C) XO type sex determination : Grasshopper ✓

(D) T.H. Morgan : Linkage ✓

Q 15 Which of the following characteristics represent 'Inheritance of blood groups' in humans? (2018)

(a) Dominance ✓ $(I^A i)\ I^B i$

(b) Co-dominance – $I^A I^A$

(c) Multiple dominance (allele) ✗

(d) Incomplete dominance

(e) Polygenic inheritance

(A) b, c and e

(B) a, b and c

(C) b, d and e

(D) a, b and e

Q 16 A woman has an X-linked condition on one of her X- chromosomes. This chromosome can be inherited by: (2018)

(A) Only daughters

(B) Only sons

(C) Only grandchildren

(D) Both sons and daughters

Q 17 Among the following characters, which one was not considered by Mendel in his experiments on pea?(2017-Delhi)

(A) Stem – Tall or Dwarf

(B) Trichomes – Glandular or non-glandular

(C) Seed – Green or Yellow

(D) Pod – Inflated or Constricted

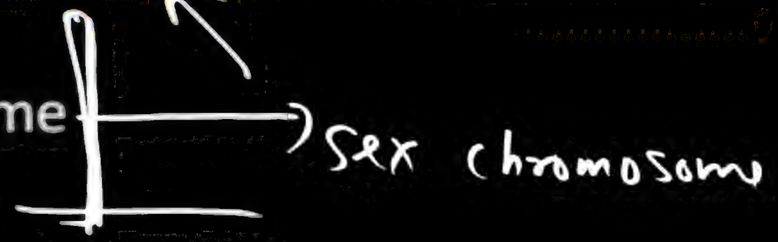
Q 18 A disease caused by an autosomal primary non-disjunction is (2017-Delhi)

(A) Down's syndrome

(B) Klinefelter's syndrome

(C) Turner's syndrome

(D) Sickle cell anemia



Q 19 The genotypes of a Husband and Wife are IAIB and IAi. Among the blood types of their children, how many different genotypes and phenotypes are possible? (2017-Delhi)

(A) 3 genotypes ; 3 phenotypes

(B) 3 genotypes ; 4 phenotypes

(C) 4 genotypes ; 3 phenotypes

(D) 4 genotypes ; 4 phenotypes

$I^A I^B$ $I^A i$

$I^A I^A$ $I^A i$ $I^A I^B$ $I^B i$ $G = 4$

A AB B $P = 3$

Q 20 Which one from those given below is the period for Mendel's hybridisation experiments? (2017-Delhi)

(A) 1856 - 1863

(B) 1840 - 1850

(C) 1857 - 1869

(D) 1870 - 1877

Q 21 Thalassemia and sickle cell anemia are caused due to a problem in globin molecule synthesis. Select the correct statement. (2017-Delhi)

(A) Both are due to a qualitative defect in globin chain synthesis

(B) Both are due to a quantitative defect in globin chain synthesis

(C) Thalassemia is due to less synthesis of globin molecules

(D) Sickle cell anemia is due to a quantitative problem of globin molecules

Q 22

Select the wrong statement: (2017-Gujarat)

(A) Chromosomal Theory of inheritance was proposed by Sutton ← NCERT

(B) Law of Dominance and Law of independent assortment were proposed by Mendel

(C) Linkage and recombination were discovered by Sutton

(D) Three scientists independently rediscovered the Mendel's laws in 1900

Q 23 The recessive genes located on X-chromosome in humans are always: (2017-Gujarat)

(A) Sub-lethal

(B) Expressed in females

(C) Expressed in males

(D) Lethal → Always

Q 24 Which one of the following is not true for the experiments of Mendel on pea? (2017-Gujarat)

(A) His experiments had small sampling size

(B) He chooses characters of two contrasting states

(C) He used true-breeding lines

(D) His observations were based on natural, open pollination

selfing

Q 25 Select the correct option: (2017-Gujarat)

(A) Klinefelter's syndrome is due to an extra X chromosome and results in sterile male

(B) Phenylketonuria is X linked disease and results in accumulation of phenyl pyruvic acid

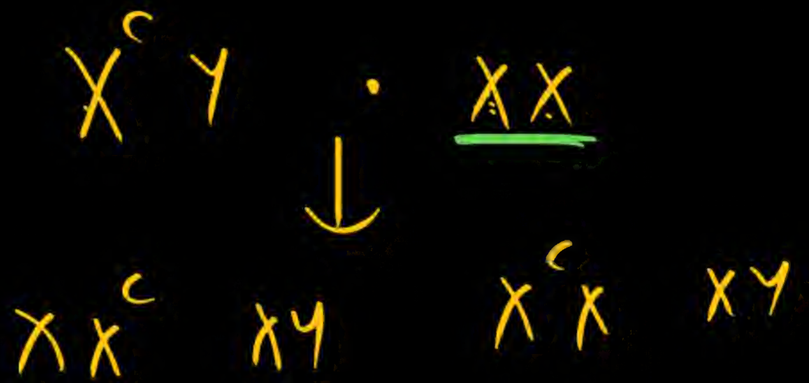
(C) Down's syndrome is due to triploidy and results in mental retardation

(D) Turner's syndrome is due to trisomy and results in sterile female

44 + XO

Q 26 If a colour-blind man marries a woman who is homozygous for normal colour vision, the probability of their son being colour-blind is:(2016 - II)

(A) 0.75
(B) 1
(C) 0
(D) 0.5



Q 27 A true breeding plant is: (2016 - II)

(A) Near homozygous and produces off spring of its own kind

(B) Always homozygous recessive in its genetic constitution

(C) One that is able to breed on its own

(D) Produced due to cross-pollination among unrelated plants

Q 28 A cell at telophase stage is observed by a student in a plant brought from the field. He tells his teacher that this cell is not like other cells at telophase stage. There is no formation of cell plate and thus the cell is containing more number of chromosomes as compared to other dividing cells. This would result in: (2016 - I)

(A) Aneuploidy

(B) Polyploidy

(C) Soma clonal variation

(D) Polyteny

Q 29 In a test cross involving F_1 dihybrid flies, more parental type off spring were produced than the recombinant-type off spring. This indicates (2016 - I)

(A) The two genes are located on two different chromosomes

(B) Chromosomes failed to separate during meiosis

(C) The two genes are linked and present on the same chromosome

(D) Both of the characters are controlled by more than one gene

Q 30 Pick out the correct statements: (2016 - I)

(a) Haemophilia is a sex-linked recessive disease.

(b) Down's syndrome is due to aneuploidy.

(c) Phenylketonuria is an autosomal recessive gene disorder.

(d) Sickle cell anemia is an X-linked recessive gene disorder.

(A) (a) and (d) are correct

(B) (b) and (d) are correct

(C) (a), (c) and (d) are correct

(D) (a), (b) and (c) are correct

Q 30 Match the terms in Column I with their description in Column II and choose the correct option: (2016 - I)

Codes

(A) a-(ii), b-(i), c-(iv), d-(iii)

(B) a-(ii), b-(iii), c-(iv), d-(i)

(C) a-(iv), b-(i), c-(ii), d-(iii)

(D) a-(iv), b-(iii), c-(i), d-(ii)

	Column I		Column II
a	Dominance	i	Many genes govern a single character
b	Codominance	ii	In a heterozygous organism only one allele expresses itself
c	Pleiotropy	iii	In a heterozygous organism both alleles express themselves fully
d	Polygenic Inheritance	iv	A single gene influences many characters

Q 32 A tall true breeding garden pea plant is crossed with a dwarf true breeding garden pea plant. When the F1 plants were selfed the resulting genotypes were in the ratio of: (2016 - I)

(A) 1 : 2 : 1 : Tall homozygous : Tall heterozygous : Dwarf

(B) 1 : 2 : 1 : Tall heterozygous : Tall homozygous : Dwarf

(C) 3 : 1 : Tall : Dwarf

(D) 3 : 1 : Dwarf : Tall

Q 33 Which of the following most appropriately describes hemophilia? (2016 - I)

(A) Recessive gene disorder

(B) X-linked recessive gene disorder

(C) Chromosomal disorder

(D) Dominant gene disorder

Q 34 How many pairs of contrasting characters in pea plants were studied by Mendel in his experiments? (2016 - I)

(A) Eight
(B) Seven
(C) Five
(D) Six

Q 35 A man with blood group 'A' marries a woman with blood group 'B'. What are all the possible blood groups of their off spring's? (2016 - I)

(A) A, B, AB and O

(B) O only

(C) A and B only

(D) A, B and AB only

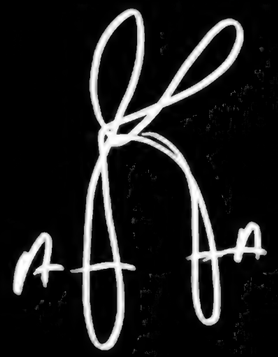
Q 36 Multiple alleles are present: (2015)

(A) At the same locus of the chromosome

(B) On non-sister chromatids

(C) On different chromosomes

(D) At different loci on the same chromosome



Q 37 The movement of a gene from one linkage group to another is called: (2015)

(A) Translocation

(B) Crossing over

(C) Inversion

(D) Duplication

Ichromosome

Q 38 Alleles are: (2015)

(A) Different molecular forms of a gene

(B) Heterozygote's

(C) Different phenotype

(D) True breeding homozygote's

Q 39 An abnormal human baby with 'XXX' sex chromosomes was born due to: (2015)

(A) Fusion of two ova and one sperm

(B) Fusion of two sperms and one ovum

(C) Formation of abnormal sperms in the father

(D) Formation of abnormal ova in the mother

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Q 40

In sea urchin DNA, which is double stranded, 17% pf the bases were shown to be cytosine. The percentage of the other three bases expected to be present in this DNA are: (2015)

(A) G-17%, A-33%, T-33%

(B) G-8.5%, A-50%, T-24.5%

(C) G-34%, A-24.5%, T-24.5%

(D) G-17%, A-16.5%, T-32.5%

Q 41 A colour blind man marries a woman with normal sight who has no history of colour blindness in her family. What is the probability of their grandson being colour blind? (2015 Re)

(A) 1

(B) Nil

(C) 0.25

(D) 0.5

Q 42 The term “linkage” was coined by: (2015 Re)

(A) T. Boveri

(B) G. Mendel

(C) W. Sutton

(D) T.H. Morgan

Q 43 A gene showing co-dominance has: (2015 Re)

(A) Alleles tightly linked on the same chromosome

(B) Alleles that is recessive to each other

(C) Both alleles independently expressed in the heterozygote

(D) One allele dominant on the other

Q 44

A pleiotropic gene: (2015 Re)

(A) Is a gene evolved during Pliocene

(B) Controls a trait only in combination with another gene

(C) Controls multiple traits in an individual

(D) Is expressed only in primitive plants

Q 45 In his classic experiments on pea plants, Mendel did not use: (2015 Re)

(A) Pod length

(B) Seed shape

(C) Flower position

(D) Seed colour

Q 46 Fruit colour in squash is an example of: (2014)

(A) Inhibitory genes

(B) Recessive epistasis

(C) Dominant epistasis

(D) Complementary genes

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Q 47 A human female with Turner's syndrome: (2014)

(A) Is able to produce children with normal husband

(B) Has 45 chromosomes with XO

(C) Has one additional X chromosome

(D) Exhibits male characters

Q 48 A man whose father was colour blind marries a woman who had a colour blind mother and normal father. What percentage of male children of this couple will be colour blind? (2014)

(A) 75%

(B) 25%

(C) 0%

(D) 50%

Q 49

The incorrect statement with regard to Haemophilia is: (2013)

(A) A single protein involved in the clotting of blood is affected

(B) It is a sex - linked disease

(C) It is a recessive disease

(D) It is a dominant disease

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Q 50 If two persons with 'AB' blood group marry and have sufficiently large number of children, these children could be classified as 'A' blood group : 'AB' blood group : 'B' blood group in 1 : 2 : 1 ratio. Modern technique of protein electrophoresis reveals presence of both 'A' and 'B' type proteins in 'AB' blood group individuals. This is an example of: (2013)

(A) Complete dominance
(B) Co-dominance
(C) Incomplete dominance
(D) Partial dominance

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Molecular Basis of inheritance

lecture-01

Botany

TARUN SIR

Topic

structure of nucleic Acid ✓ (Biomolecule) Question - 7

Discovery of DNA ⟶

Watson and crick model ⟶

Packaging of DNA ⟶

Search of Genetic material ⟶ (Experiments)

DNA Replication (Experiment, Process)

Transcription – Process

Type of RNA →

Genetic code →

Translation →

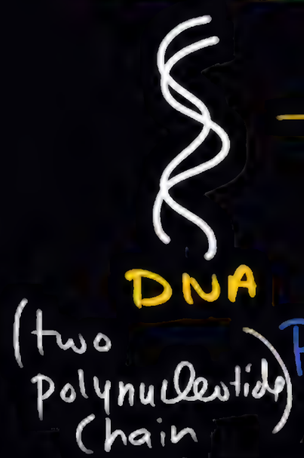
Gene Expression →

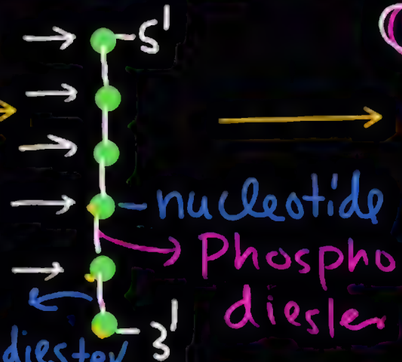
Human Genome project →

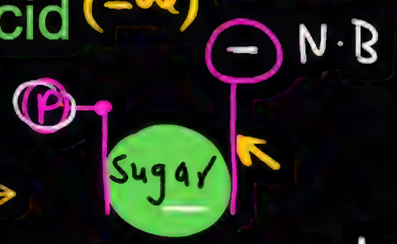
DNA fingerprinting →

Structure of Nucleic Acid

DNA, RNA → Nucleic Acid (-ve)

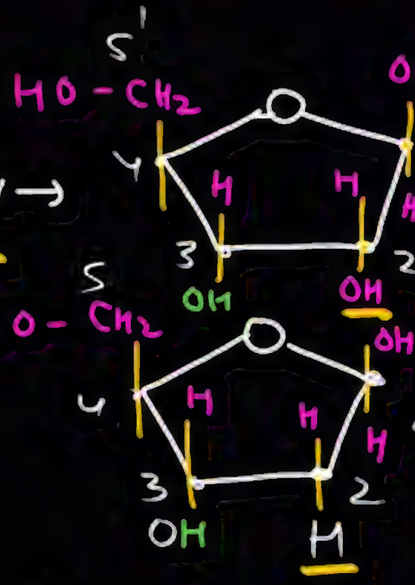






Nucleotide (S+N·B+P)

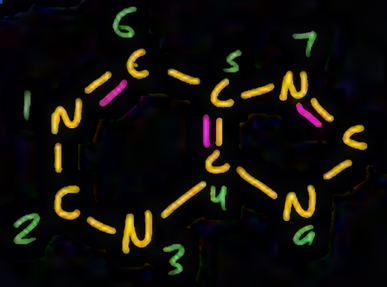
Sugar →



Ribose (5C) ($C_5H_{10}O_5$)

Deoxyribose $C_5H_{10}O_4$

N·B → Purine → A, G

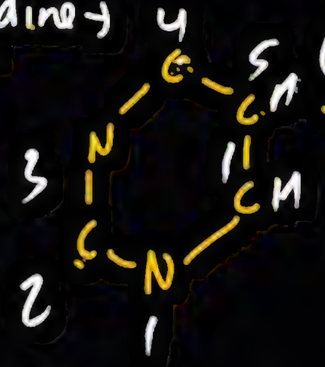


→ Adenine → 6-Amino purine

→ Guanine → 2 Amino, 6 oxo purine

(Double Ring, 9 member, N_1 N_3 N_7 N_9)

Pyrimidine → C U T



C U T – Cytosine → 4th Amination

– Uracil → 2,4 dioxo pyrimidine

↓ 5th methyl

– Thymine → 5-metyl uracil

(Single Ring, N_1, N_3)

Nucleoside Sugar + A(N·B → Adenosine (deoxy)
(N-Glycosidic) (deoxyribose) + G → Guanosine
+ C → Cytidine
+ T → Thymidine

Sugar + A
(Ribose) U ← Uridine
G
C

(Ribose / Deoxyribose) – C_1
N·B – Purine – N_9
Pyrimidine + N_1

Nucleotide → Nucleoside + P

Phosphoester

Phospho anhydride

N-Glycosidic

5′ $(P)-O-CH_2$

3′–5′ Phosphodiester linkage

Phosphoester

$HO-P=O$

O – Phosphoester

3′–OH

5′ $(P)-CH_2-N\cdot B$

P – N·B – P – N·B – P – N·B – P – N·B – P – N·B

Phospho diester

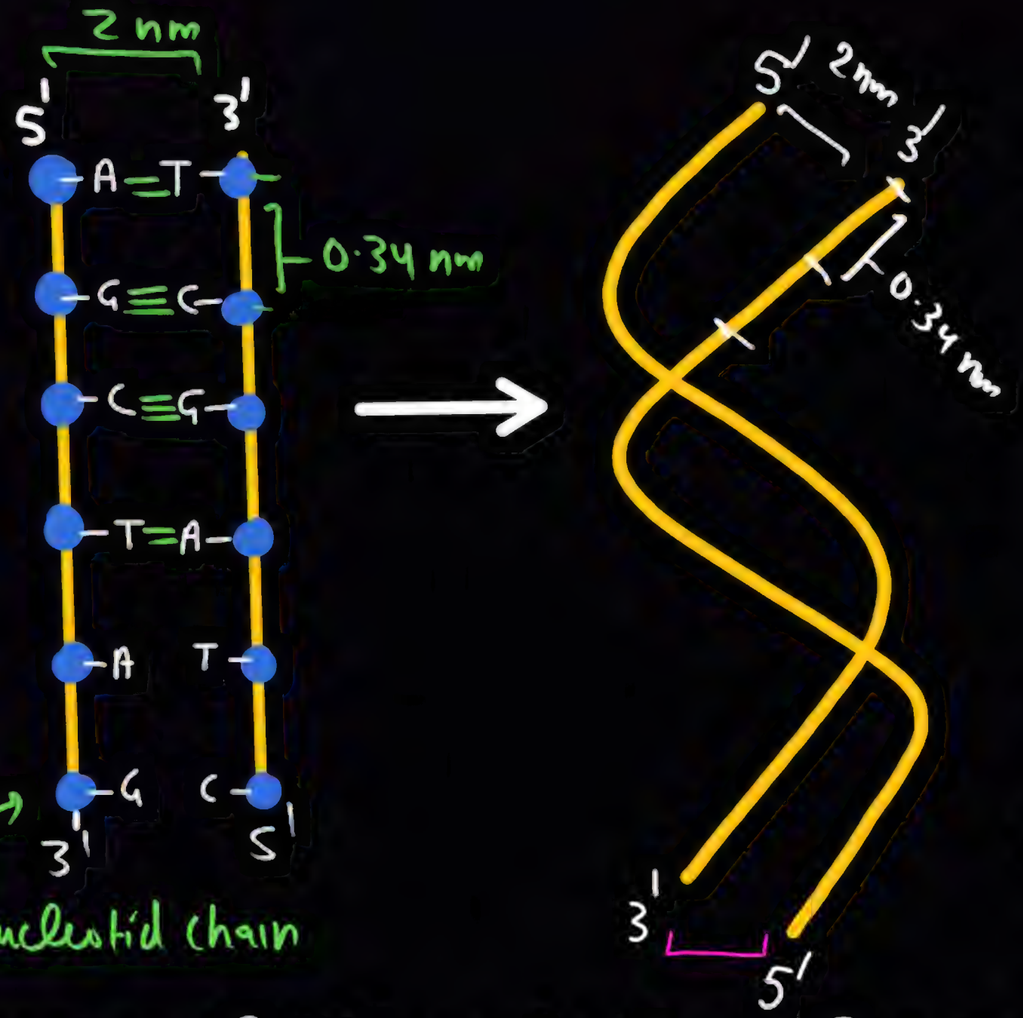
3′–OH

5′

3′

Polynucleotide Chain

two phosphate Remove



Detail of DNA

1 turn = 10 base pair

① B-type → (most common type)

② Right handed coil →

(c) Double helix / Antiparallel chain

(d) Distance B/w two chain ⇒ 2 nm

(e) Distance B/w two base pair – 0·34 nm

(f) 1 turn ⇒ 10 Base Pair (Length of 1 turn ⇒ 3·4nm)

(g) Length of DNA → 0·34 nm X Base pair

B type DNA – Right handed coil → Rise per Base pair – 36°

– 1 turn → 10 Bp

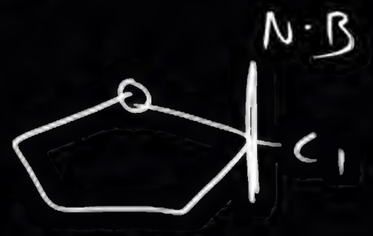
→ 1 turn pitch – 3·4nm

Q1 5 methyl uracil

(a) N·B (b) Nucleoside (c) Sugar (d) Pyridine

Q2 Carbon of sugar Attach to N·B

(a) C-1 (b) C-2 (c) C-3 (d) C-4



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Q 100 Bp DNA, if A = 60 Calculate H-Bond →

100 Bp → 200 Bases →

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G = 40 C = 40

40 × 3 + 60 × 2 = 240

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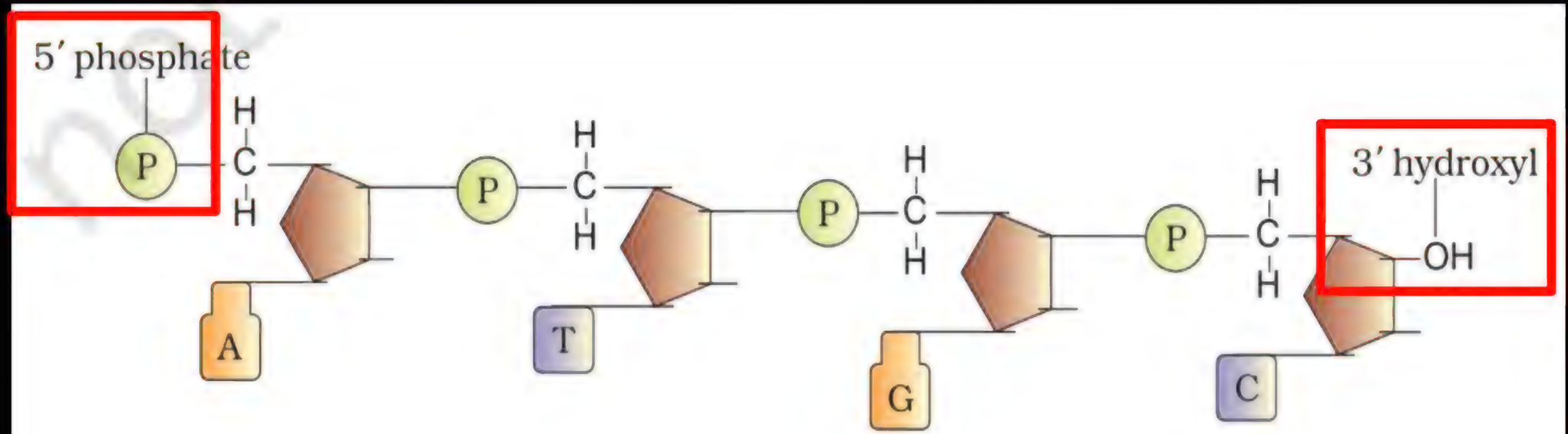
Let us recapitulate the chemical structure of a polynucleotide chain (DNA or RNA). A nucleotide has three components – a nitrogenous base, a pentose sugar (ribose in case of RNA, and deoxyribose for DNA), and a phosphate group. There are two types of nitrogenous bases - Purines (Adenine and Guanine), and Pyrimidines (Cytosine, Uracil and Thymine). Cytosine is common for both DNA and RNA and Thymine is present in DNA. Uracil is present in RNA at the place of Thymine. A nitrogenous base is linked to the OH of 1′C pentose sugar through a N-glycosidic linkage to form a nucleoside, such as adenosine or deoxyadenosine, guanosine or deoxyguanosine, cytidine or deoxycytidine and uridine or deoxythymidine. When a phosphate group is linked to OH of 5′C of a nucleoside through phosphoester linkage, a corresponding nucleotide (or deoxynucleotide depending upon the type of sugar present) is formed. Two nucleotides are linked through 3′-5′ phosphodiester linkage to form a dinucleotide. More nucleotides can be joined in such a manner to form a polynucleotide chain. A polymer thus formed has at one end a free



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What is Genetic material

→ Genetic material ⟶ Sum total of all Gene

Structure → It can be DNA or RNA

→ In all living cell ⟶ Genetic material is → DNA (Double strand) Bacteria, Human, Plant, protista, Algae

Role of RNA is → messenger → mRNA
(living cell) Catalyst & structural → rRNA
Adaptor ⟶ tRNA

→ RNA is Genetic material in ⟶ Virus

→ length of DNA or RNA is measured in →
- no. of nucleotide → Single strand
- Base pair → Double strand →

Virus → ① X174 → SS DNA virus → 5386 nucleotide

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Human → Haploid → 3.3×10^9 Bp

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DNA is a long polymer of deoxyribonucleotides. The length of DNA is usually defined as number of nucleotides (or a pair of nucleotide referred to as base pairs) present in it. This also is the characteristic of an organism. For example, a bacteriophage known as ϕ×174 has 5386 nucleotides, Bacteriophage lambda has 48502 base pairs (bp), *Escherichia coli* has 4.6×10^6 bp and haploid content of human DNA is 3.3×10^9 bp. Let us discuss the structure of such a long polymer.

In the previous chapter, you have learnt the inheritance patterns and the genetic basis of such patterns. At the time of Mendel, the nature of those 'factors' regulating the pattern of inheritance was not clear. Over the next hundred years, the nature of the putative genetic material was investigated culminating in the realisation that DNA – deoxyribonucleic acid – is the genetic material, at least for the majority of organisms. In class XI you have learnt that nucleic acids are polymers of nucleotides.

Deoxyribonucleic acid (DNA) and ribonucleic acid (RNA) are the two types of nucleic acids found in living systems. DNA acts as the genetic material in most of the organisms. RNA though it also acts as a genetic material in some viruses, mostly functions as a messenger. RNA has additional roles as well. It functions as adapter, structural, and in some cases as a catalytic molecule. In Class XI you have already learnt the structures of nucleotides and the way these monomer units are linked to form nucleic acid polymers. In this chapter we are going to discuss the structure of DNA, its replication, the process of making RNA from DNA (transcription), the genetic code that determines the sequences of amino acids in proteins, the process of protein synthesis (translation) and elementary basis of their regulation. The determination

of complete nucleotide sequence of human genome during last decade has set in a new era of genomics. In the last section, the essentials of human genome sequencing and its consequences will also be discussed.

Let us begin our discussion by first understanding the structure of the most interesting molecule in the living system, that is, the DNA. In subsequent sections, we will understand that why it is the most abundant genetic material, and what its relationship is with RNA.

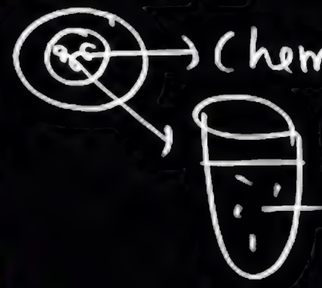
cell theory

Discovery of DNA

I

Meischer → 1869 → From nucleus chemical Isolate → which was Acidic → known as Nuclein

techical limitation → Intact Form (not Able to Isolate)



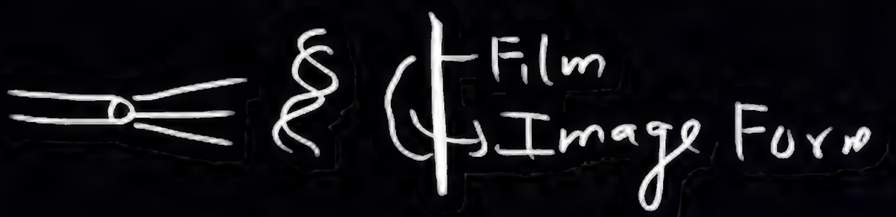
Chemical Isolate → Nuclein (Acidic)

nuclein Break → Structure not Elucidated

II

Wilkins and Franklin →

Use X-ray to Give DNA X-ray Crystallography Structure



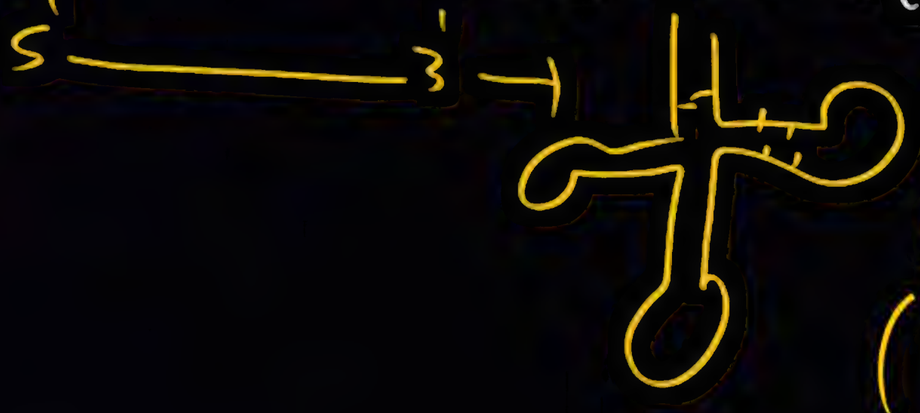
Chargaff's → Ratio of Adenine to thymine & Guanine to cytosine is constant & Equal to 1

$\frac{A}{T} = \frac{G}{C} = 1$ or $A = T$, $G = C$ or $\frac{A^{20} + G^{30}}{T_{20} + C_{30}} = 1$ or $\frac{A+T}{G+C}$ → not chargaff's Rule

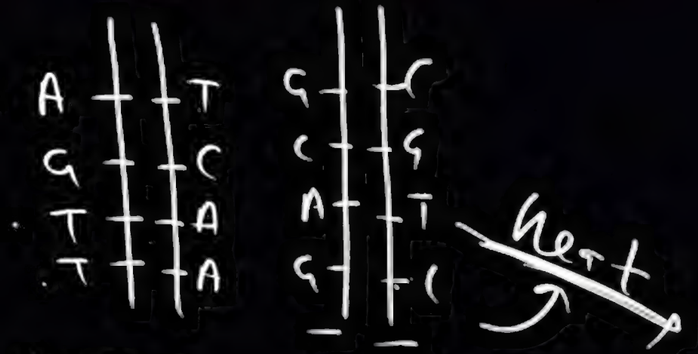
(Base Ratio → tell stability of DNA)

① Chargaff → Double strand – DNA ✓
(all cell)
Double strand – RNA (Some Virus)

② Living cell → RNA (Single chain)
↓
Double strand (within chain) From



Double Strand t-RNA (within chain)



$\frac{A+T}{G+C} \Rightarrow$ $2+2+2+3$ $\Rightarrow 9$

$\frac{A+T}{G+C} \Rightarrow$ 11

→ No chargaff's Rule

Q Findings of _____ help in Watson & Crick model

(a) Wilkins (b) Franklins (c) Chargaff (d) all

Q2 Acc. to chargaff's rule all Except

(a) $A=T$, $G=C$ (b) $\frac{A}{T}=\frac{G}{C}=1$ (c) $\frac{A+G}{T+C}$ (d) $\frac{A+T}{G+C}$

Q3 Stable DNA have Base Ratio $\rightarrow \frac{A+T}{G+C}$ is

(a) high (b) low (c) 1 (d) none

Q4 two DNA P & Q (P-Base Ratio $\rightarrow 0.7$) (Q = 1) Which is stable

More Stable

(1) P (2) Q

DNA as an acidic substance present in nucleus was first identified by Friedrich Meischer in 1869. He named it as 'Nuclein'. However, due to technical limitation in isolating such a long polymer intact, the elucidation of structure of DNA remained elusive for a very long period of time. It was only in 1953 that James Watson and Francis Crick, based on the X-ray diffraction data produced by Maurice Wilkins and Rosalind Franklin, proposed a very simple but famous **Double Helix** model for the structure of DNA. One of the hallmarks of their proposition was base pairing between the two strands of polynucleotide chains. However, this proposition was also based on the observation of Erwin Chargaff that for a double stranded DNA, the ratios between **Adenine** and **Thymine** and **Guanine** and **Cytosine** are constant and equals one.

MANTHAN NEET 2025 1.0 to 2.0

SANKALP NEET VEDANTU

Molecular Basis of inheritance

lecture-02

Botany

TARUN SIR

Topic

structure of nucleic Acid ✓ (Biomolecule) Question - 7

Discovery of DNA ⟶ ✓

Watson and crick model ⟶

Packaging of DNA ⟶

Search of Genetic material ⟶ (Experiments)

DNA Replication (Experiment, Process)

Transcription – Process

Type of RNA →

Genetic code →

Translation →

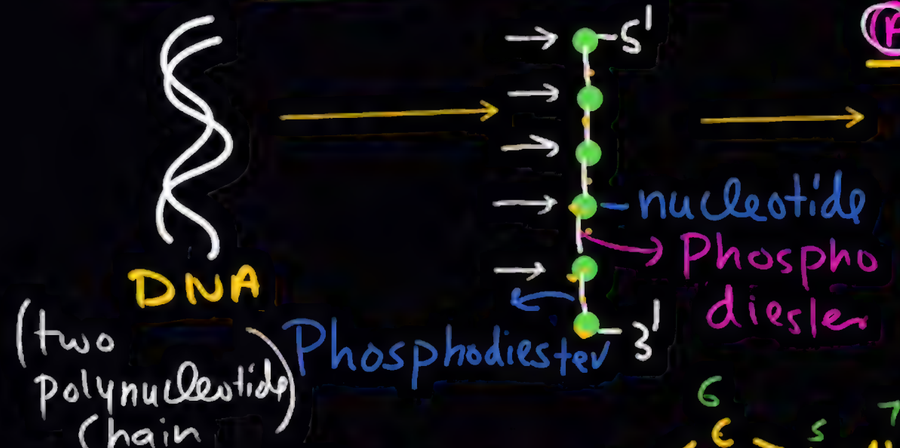
Gene Expression →

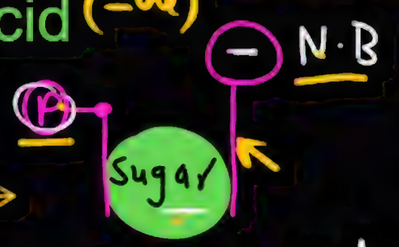
Human Genome project →

DNA fingerprinting →

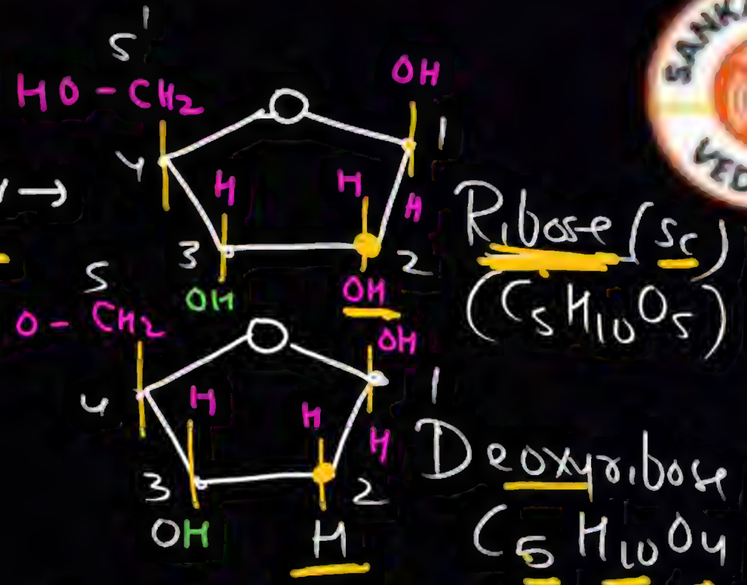
Structure of Nucleic Acid

DNA, RNA → Nucleic Acid (-ve)

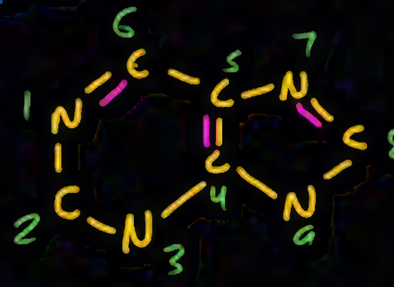




Nucleotide (S+N·B+P)



N·B → Purine → A, G



→ Adenine → 6-Amino purine

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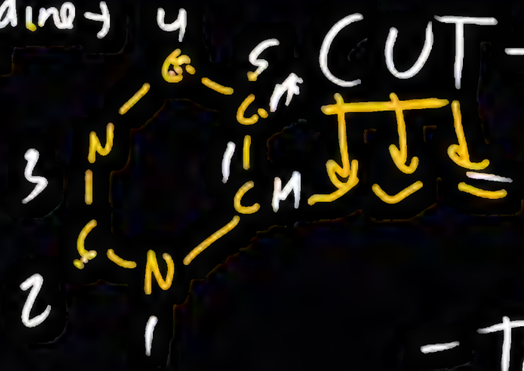
Pyrimidine → C U T



CUT – Cytosine → 4th Amination

Uracil → 2,4 dioxo pyrimidine (Single Ring N1, N3)

↓ 5th methyl

– Thymine → 5-metyl uracil

Nucleoside Sugar + A(N·B → Adenosine (deoxy)
(N-Glycosidic) (deoxyribose) + G → Guanosine
+ C → Cytidine
+ T → Thymidine

Sugar + A
(Ribose) U ← Uridine
G
C

(Ribose / Deoxyribose) – C1
N·B – Purine – N9
Pyrimidine + N1

Nucleotide → Nucleoside + P

Phosphoester

Phospho anhydride

N-Glycosidic

3'–5' Phosphodiester linkage

Phosphoester

Phosphoester

two phosphate Removed

Phospho diester

Polynucleotide Chain

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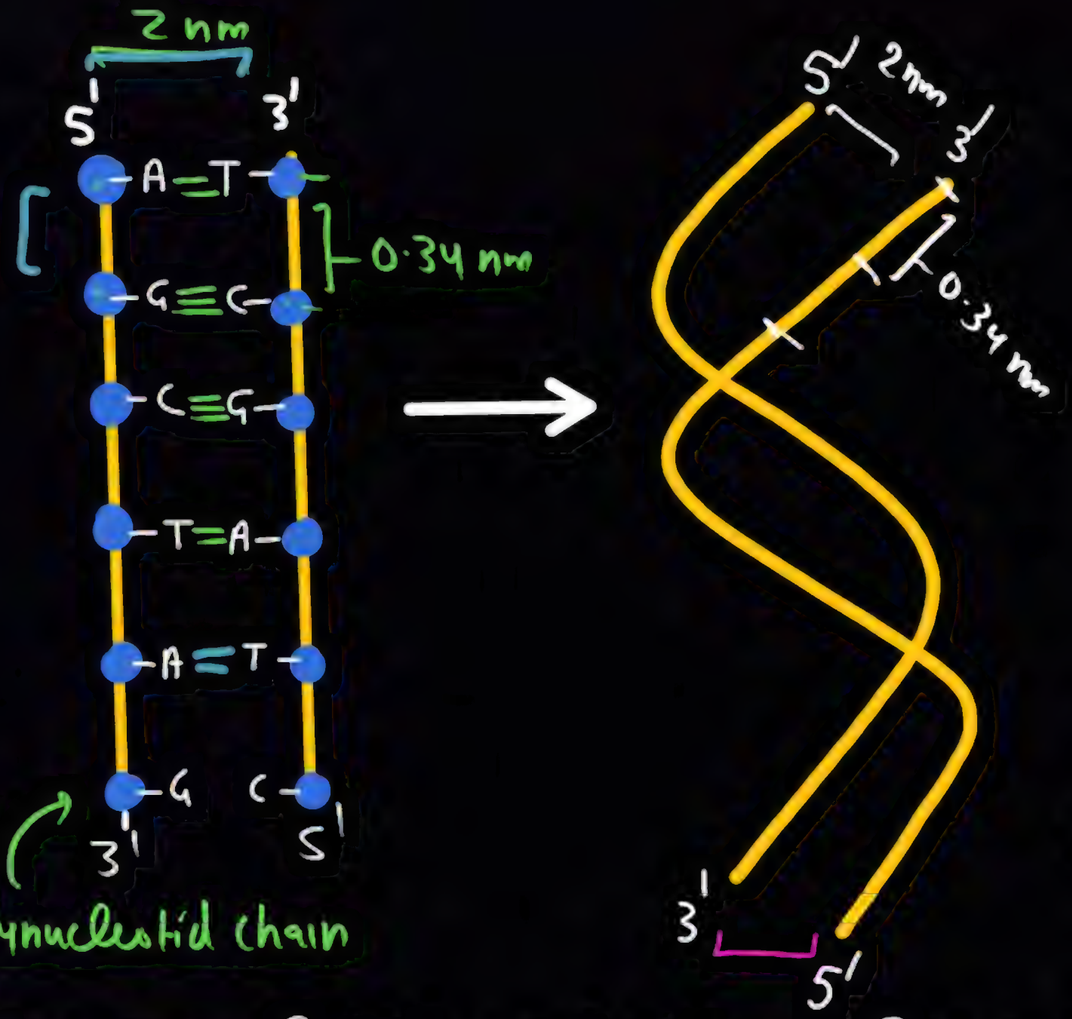

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1 turn = 10 base pair

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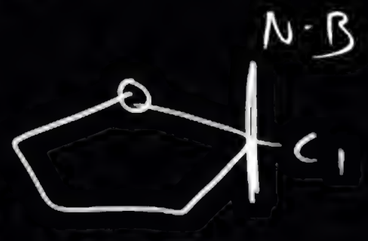

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40 × 3 + 60 × 2 ⇒ 240

cell theory

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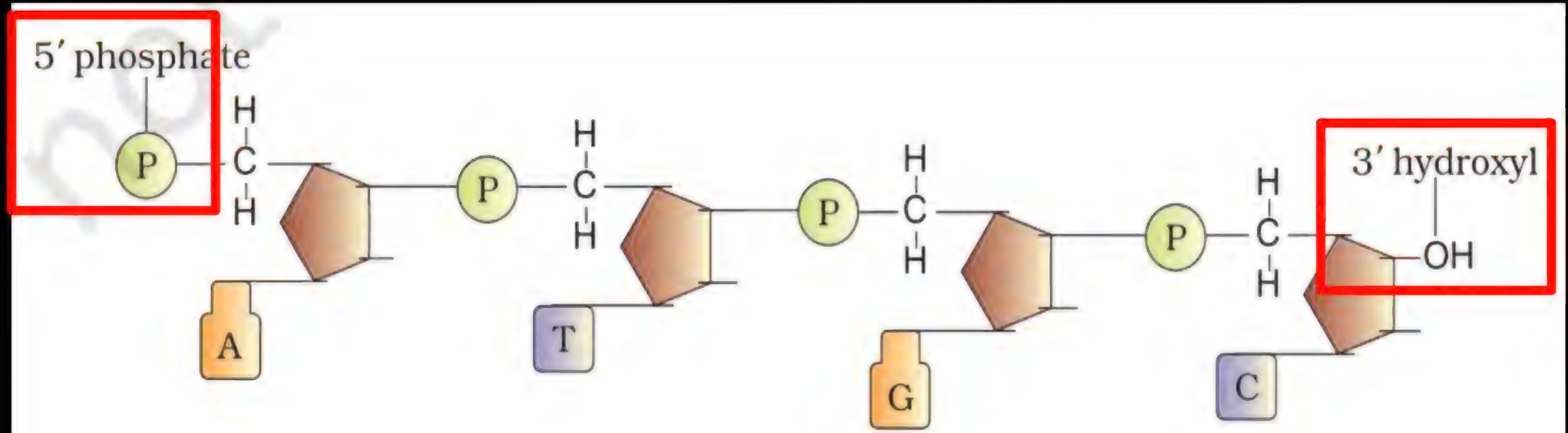

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cell theory

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1900 → 2000

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cell theory

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cell theory

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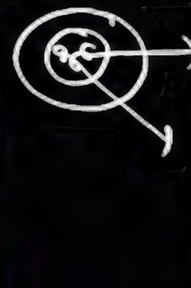


Chemical Isolate → Nuclein (Acidic)

nuclein Break → Structure not Elucidated

II

Wilkins and Franklin →

Use X-ray to Give DNA X-ray Crystallography Structure

Film → Image Form

Chargaff's → Ratio of Adenine to thymine & Guanine to cytosine is constant & Equal to 1

$$\frac{A}{T}=\frac{G}{C}=1$$

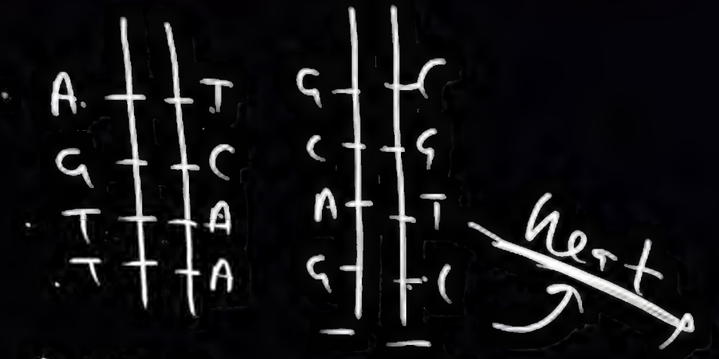
or $A=T$ (10 + 20 = 30), $G=C$ (10 + 20 = 30)

or $\frac{A+G}{T+C}=1$ (A: 20, G: 30; T: 20, C: 30)

or $\frac{A+T}{G+C}$ → not Chargaff's Rule

(Base Ratio → tell stability of DNA)

① Chargaff → Double strand – DNA ✓
(all cell)
Double strand – RNA (Some Virus)



$\frac{A+T}{G+C} = 2$ $\quad$ $\frac{A+T}{G+C} = 3$

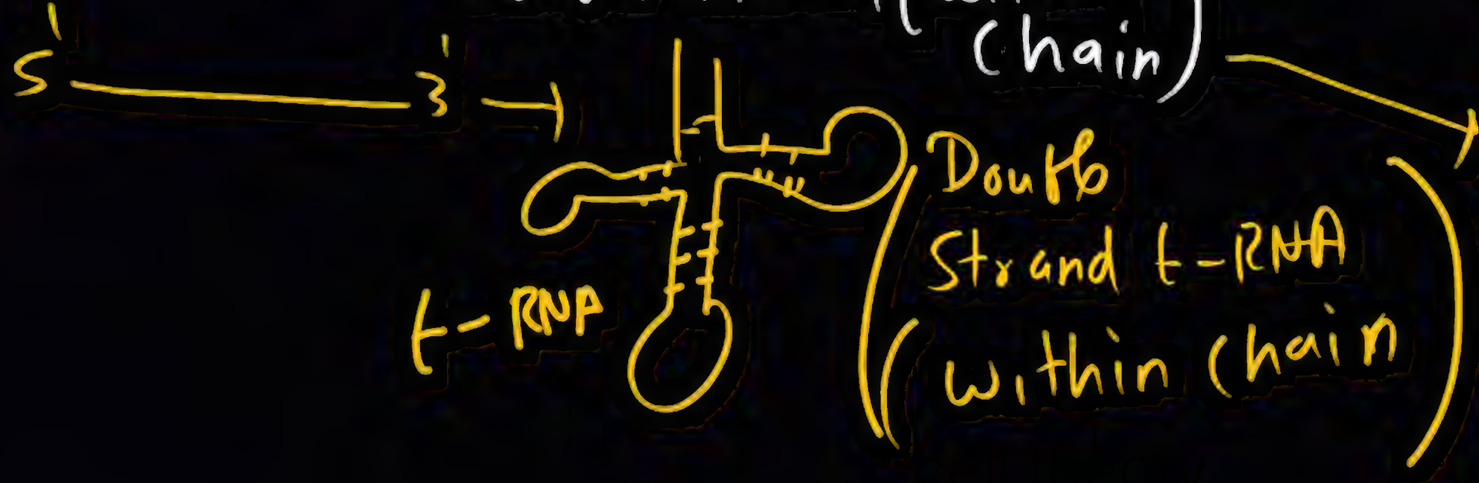
2+2+2+3 $\quad$ 11

⇒ 9

② Living cell → RNA (Single chain)

↓

Double strand (From within chain)



→ No chargaff' Rule

Q Findings of _____ help in Watson & Crick model

(a) Wilkins (b) Franklins (c) Chargaff (d) all

Q2 Acc. to chargaff's rule all Except

(a) $A=T$, $G=C$ (b) $\frac{A}{T}=\frac{G}{C}=1$ (c) $\frac{A+G}{T+C}$ (d) $\frac{A+T}{G+C}$

Q3 Stable DNA have Base Ratio → $\frac{A+T}{G+C}$ is

(a) high (b) low (c) 1 (d) none

Q4 two DNA P & Q (P-Base Ratio → 0.7) (Q = 1) Which is stable

More Stable

(1) P (2) Q

cell theory

DNA as an acidic substance present in nucleus was first identified by Friedrich Meischer in 1869. He named it as 'Nuclein'. However, due to technical limitation in isolating such a long polymer intact, the elucidation of structure of DNA remained elusive for a very long period of time. It was only in 1953 that James Watson and Francis Crick, based on the X-ray diffraction data produced by Maurice Wilkins and Rosalind Franklin, proposed a very simple but famous **Double Helix** model for the structure of DNA. One of the hallmarks of their proposition was base pairing between the two strands of polynucleotide chains. However, this proposition was also based on the observation of Erwin Chargaff that for a double stranded DNA, the ratios between **Adenine** and **Thymine** and **Guanine** and **Cytosine** are constant and equals one.

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cell theory

Discovery of DNA

Meischer

Wilkins and Franklin

Chargaff's

Q Findings of _____ help in Watson & Crick model

(a) Wilkins (b) Franklins (c) Chargaff (d) all

Q2 Acc. to chargaff's rule all Except

(a) $A = T$, $G = C$ (b) $\frac{A}{T} = \frac{G}{C} = 1$ (c) $\frac{A+G}{T+C}$ (d) $\frac{A+T}{G+C}$

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cell theory

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cell theory

Watson and crick

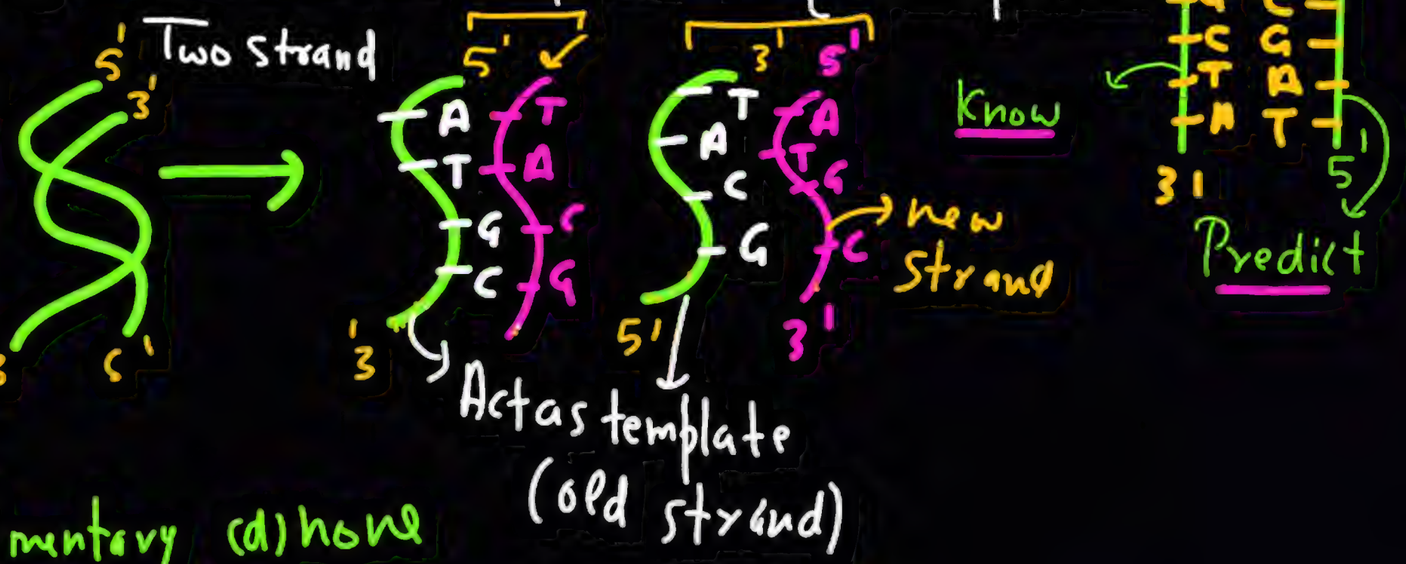
Key points → 1953 → Watson And Crick → Double helix model – 1953

- Hallmark → Complimentary Base pairing [Support From chargaff's Rule]

This help to predict → Base pairing complimentary →

– If we know the sequence one strand → predict Sequence of other

→ How DNA Replication occur



Q Hallmark of Watson and crick model

(a) Base pairing (b) H-Bond (c) complimentary Base pairing (d) none

Q DNA Replication template is

(a) One Strand (b) Both strand

The base pairing confers a very unique property to the polynucleotide chains. They are said to be complementary to each other, and therefore if the sequence of bases in one strand is known then the sequence in other strand can be predicted. Also, if each strand from a DNA (let us call it as a parental DNA) acts as a template for synthesis of a new strand, the two double stranded DNA (let us call them as daughter DNA) thus produced would be identical to the parental DNA molecule. Because of this, the genetic implications of the structure of DNA became very clear.

Salient Feature — DNA Double helix model

(a) DNA is made up of two polynucleotide chain back Bone is Sugar phosphate Backbone

(b) Two chain Antiparallel polarity → one chain 5' to 3' another chain – 3' to 5' (N·B projected inside)

(Nitrogenous Base)

(c) N·B Form H-Bond to Form Base pair

Such that → A Base pair with T (two H-Bond)
G Base pair with C (three H-Bond) (Purine Always Bond with Pyrimidine → Uniform Diameter = 2nm

(d) Two chain coiled in Right handed manner

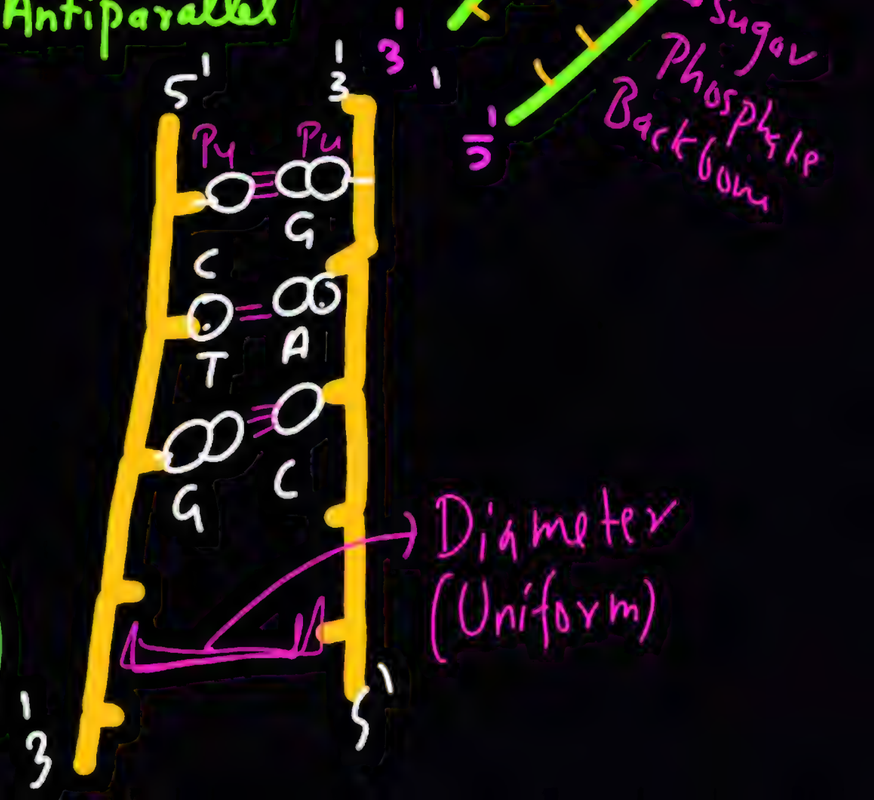
Pitch of coil is → 3·4 nm, 1 turn = 10 Base pair
(0·34 nm → Distance B/w two Base pair)

(e) Plane of Base pair – Stacked →

Stacking of Base pair & H-Bonding – Give Additional stability

Q Removal of ___ not dec·le ngth of DNA
(a) Sugar (b) N·B
(c) Phosphate (d) all

Q N·B come in Front of Each other
(a) Chain parallels
~~(b)~~ two Antiparallel



The salient features of the Double-helix structure of DNA are as follows:

(i) It is made of two polynucleotide chains, where the backbone is constituted by sugar-phosphate, and the bases project inside.

(ii) The two chains have anti-parallel polarity. It means, if one chain has the polarity 5′→3′, the other has 3′→5′.

(iii) The bases in two strands are paired through hydrogen bond (H-bonds) forming base pairs (bp). Adenine forms two hydrogen bonds with Thymine from opposite strand and vice-versa. Similarly, Guanine is bonded with Cytosine with three H-bonds. As a result, always a purine comes opposite to a pyrimidine. This generates approximately uniform distance between the two strands of the helix (Figure 5.2).

(iv) The two chains are coiled in a right-handed fashion. The pitch of the helix is 3.4 nm (a nanometre is one billionth of a metre, that is 10^{-9} m) and there are roughly 10 bp in each turn. Consequently, the distance between a bp in a helix is approximately 0.34 nm.

(v) The plane of one base pair stacks over the other in double helix. This, in addition to H-bonds, confers stability of the helical structure (Figure 5.3).

Central dogma → By Crick

→ Explain Flow of Genetic information inside cell

DNA —Transcription→ RNA —Translation→ Protein

DNA —Replication→ DNA

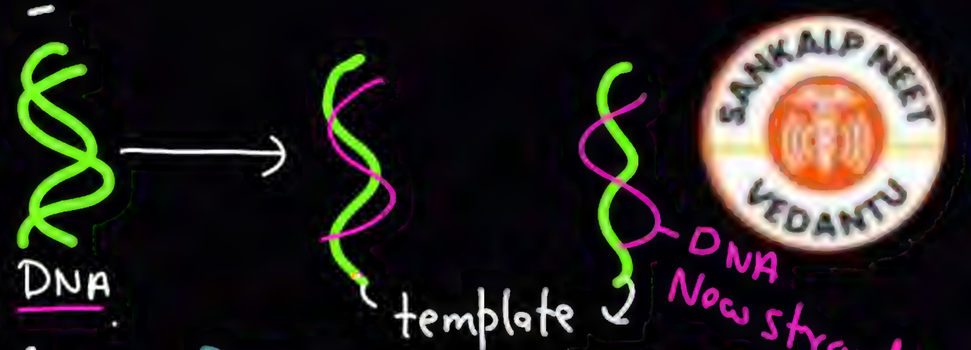
Flow of information normal cell

Some virus → RNA Genetic material

DNA —Transcription→ RNA —Translation→ Protein

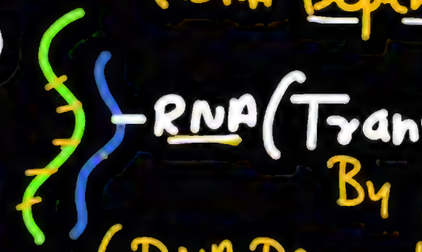
RNA —Reverse transcription→ DNA

(Such virus – Retro virus)



DNA Replication By – DNA polymerase

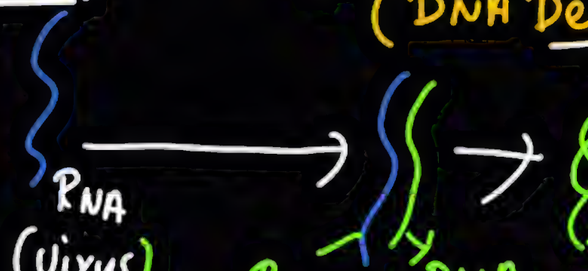
(DNA Dependent DNA polymerase)



RNA (Transcription)

By RNA polymerase

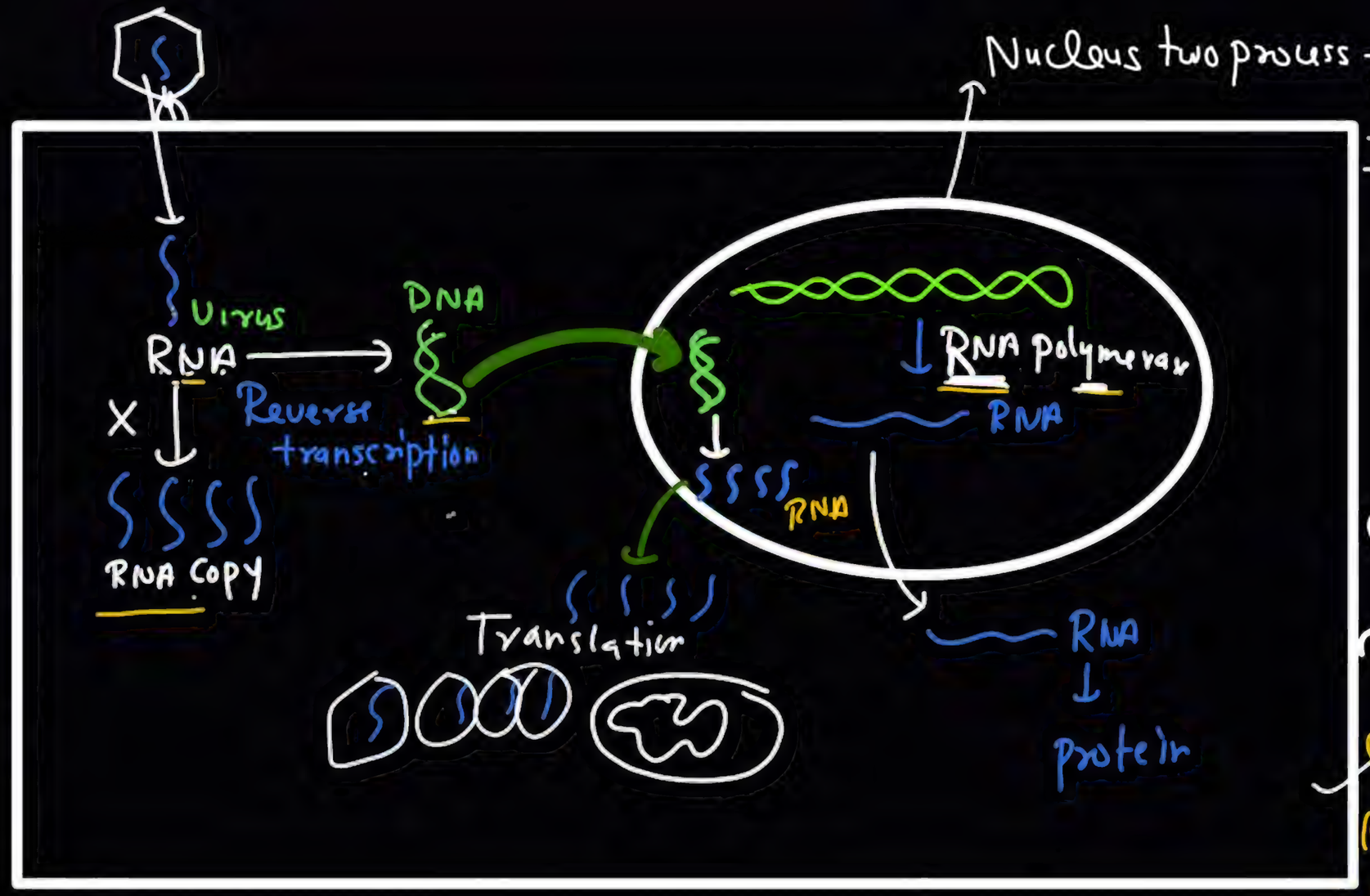
(DNA Dependent RNA polymerase)



RNA Dependent DNA polymerase

(Reverse transcriptase)

location of DNA polymerase
- Nucleus
- organell



Q Not possible in virus infected (RNA) cell

(a) DNA Dependent DNA polymerase

(b) RNA Dependent DNA polymerase

(c) RNA polymerase

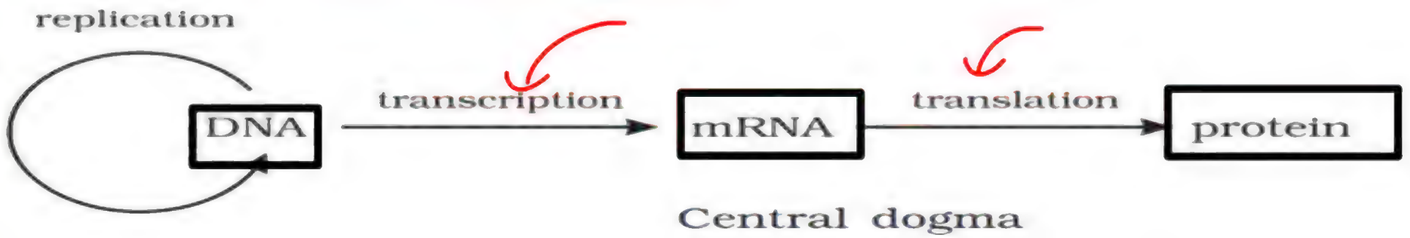
(d) RNA dependent RNA polymerase

e Cytosine

Compare the structure of purines and pyrimidines. Can you find out why the distance between two polynucleotide chains in DNA remains almost constant?

The proposition of a double helix structure for DNA and its simplicity in explaining the genetic implication became revolutionary. Very soon, Francis Crick proposed the Central dogma in molecular biology, which states that the genetic information flows from DNA→RNA→Protein.

lix



Central dogma

In some viruses the flow of information is in reverse direction that is, from RNA to DNA. *Can you suggest a simple name to the process?*

cell theory

Discovery of DNA

1869 - Meischer → Nuclein (limitation - Isolation of DNA in intact Form

Wilkins & Franklin - X-ray Diffraction

Chargaff's rule → $\frac{A+G}{T+C}=1$ $\frac{A}{T}=\frac{G}{C}=1$

DNA Double helix model

Watson & Crick - 1953 → Hallmark - Complimentary Base pairing →

Explain - DNA Replication - Sequence of other strand can be predicted

(a) DNA → two polynucleotide chain (S-P → Backbone)

(b) Direction - 5'–3' 3'–5' (N·B inside

(c) Purine Bp with Pyrimidine (Doble ring & Single ring) (A & T - two H-Bond, G & C - three H-Bond)

(c) Right Handed coil – 1 turn 10 Bp

Pitch = 3·4 nm Distance B/w two Bp = 0·34 nm

(e) H-Bond Stacking of Bp (Extra stability)

Central dogma (Crick) → DNA —Transcription→ mRNA → Protein

Replication, Translation

Flow of information, Some virus (RNA to DNA) (Reverse transcriptase) Reverse transcription (Retro virus)

Packaging of DNA

E·coli → $4·6 \times 10^6$ Bp × 0·34 nm = 1·36 mm

→ DNA is package - Basic protein

- Circular DNA, Form large loops with protein (Nucleoid)

Eukaryotes → Human → haploid - $3·3 \times 10^9$ Bp (1·1 m)

→ Diploid - $6·6 \times 10^9$ Bp (2·2 m)

- 2·2 meter in 10^{-6} m nucleus

- Histone help in packaging

Histone - Rich in lysine & Arginine (Side chain Extra NH_2) H_1 – Sealing)

octamer H_2A, H_2B, H_3, H_4

Octamer + DNA → Nucleosome (DNA - 200 Bp

Beads on string – EM – DNA + nucleosome

→ $G_1 + S + G_2$ – Chromatin most condense – M-phase

NHCs – Higher level packaging

Euchromatin - less condense, light stain

Transcriptionally Active

Heterochromatin – more condense

transcriptionally inactive

Search of Genetic material - Quest to determine genetic material - 1926

Transformation - Bacteria - Pneumonococcus → R-strain - non-virulent
→ S-strain - virulent → Smooth/shiny colony (mucus coat)

Griffith - 1928
R-strain → mice → mice Alive
S-strain - Mice killed
Heat Killed S-strain - Mice alive
R strain + Heat killed S-Strain → Mice killed

Some Tranforming principle - From Heat Killed S - transform R into S (Change into physical Form
↓ (Unknown)

Avery McCarty Macleod - Purified Biochemical
(Prior to work - Protein thought to be Genetic material

(From S-strain
- → RNAse + DNAse → No transformation
- → Protease + DNAse → No transformation
- → Protease + RNAse → Tranformation occur

In presence of DNAse
No Tranformation

Harshey and chase - 1952
Bacteriophage → Genetic material Enter
Lysis occur

S^{35} - Radioactive protein
P^{32} - Radioactive DNA

Virus with S^{35} - Radioactivity - Supernatant
Virus with P^{32} - Pellet Radioactive

Three step - Infection - Genetic material Enter
Blending - cover Removed
Centrifugation - Pellet - E.coli + Virus Genetic material
Supernatant - Virus cover

why DNA is Genetic material
Good Genetic material
(a) Structurally & Chemically stable
(b) Able to make Replica
(c) Slow mutation
(d) Express mendelian pattern

[ØB bacteriophage + TMV - RNA genetic material
- RNA - Single strand - less stable, Can Act as catalyst, 2'-OH make it labile, Uracil most Reactive
DNA - Double strand. more stable, 2'-H, thymine → Never Act as catalyst
- DNA & RNA - Both can make copy
- RNA - mutate Faster (RNA virus)
- RNA Express through protein

Storage of Genetic information - DNA
Expression - RNA

RNA world – First Genetic material RNA (Splicing, Catalyst) But Unstable
– 2'-OH change to 2'-H & Uracil to thymin ⟶ Single strand to double strand

DNA Replication ⟶ Semi-conservative – one old, one new strand [Watson & Crick – Predicted possible mode of DNA Replication]

semi conservative – 1958 (First – E. coli → Plant → Human) – Plant – Vicia Faba
Meselson & Stahl – E. coli (N^{14} & N^{15} → Heavy isotop
Radioactive thymidine – Taylor – 1958
(Semi conservative in DNA & Chromosome

E. coli ⟶ on N^{15} source
Both strand N^{15}
⟶ (NH_4Cl, N_{14} source, 20 min) ⟶ Ist Generation 100% Hybrid
⟶ IInd: 40 min, 50% Hybrid, 50% light
⟶ 3rd generation: 60 min, 25% Hybrid

Detail of DNA Replication

– Prokaryotes – Prior to Fission, Cytoplasm
Faster than Eukaryotes (2000 Bp/sec)
(Semiconservative ⟶)
– Eukaryotes – S-phase, Nucleus

R = Replicon → independent Evented DNA Replication
Origin – DNA Replication start – centre of Replicon – origin

At origin – Two Replication Forks

Main Enzyme – DNA polymerase
Template →
– Direction – 5' – 3'
– Require primer
Other name – DNA Dependent DNA polymerase
Substrate – deoxy ribose nucleoside triphosphate
(Dual Role – (i) Substrate
(ii) Energy

Steps in DNA Replication

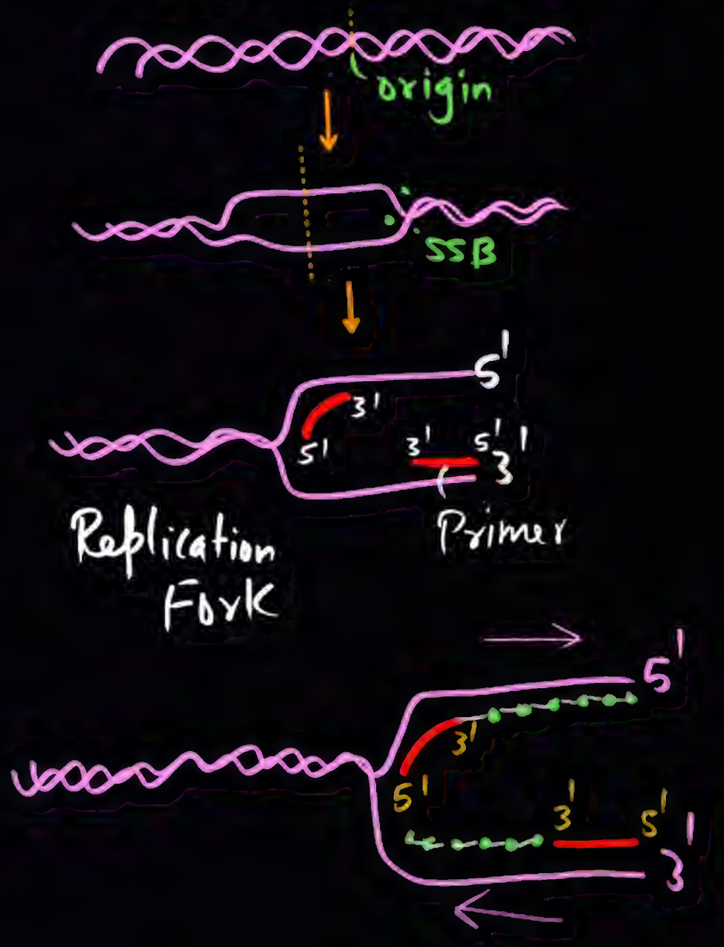
Helicase – Open DNA

Primase – Primer of RNA

SSB – Keep DNA open

Topoisomerase – dec. –ve supercoiling

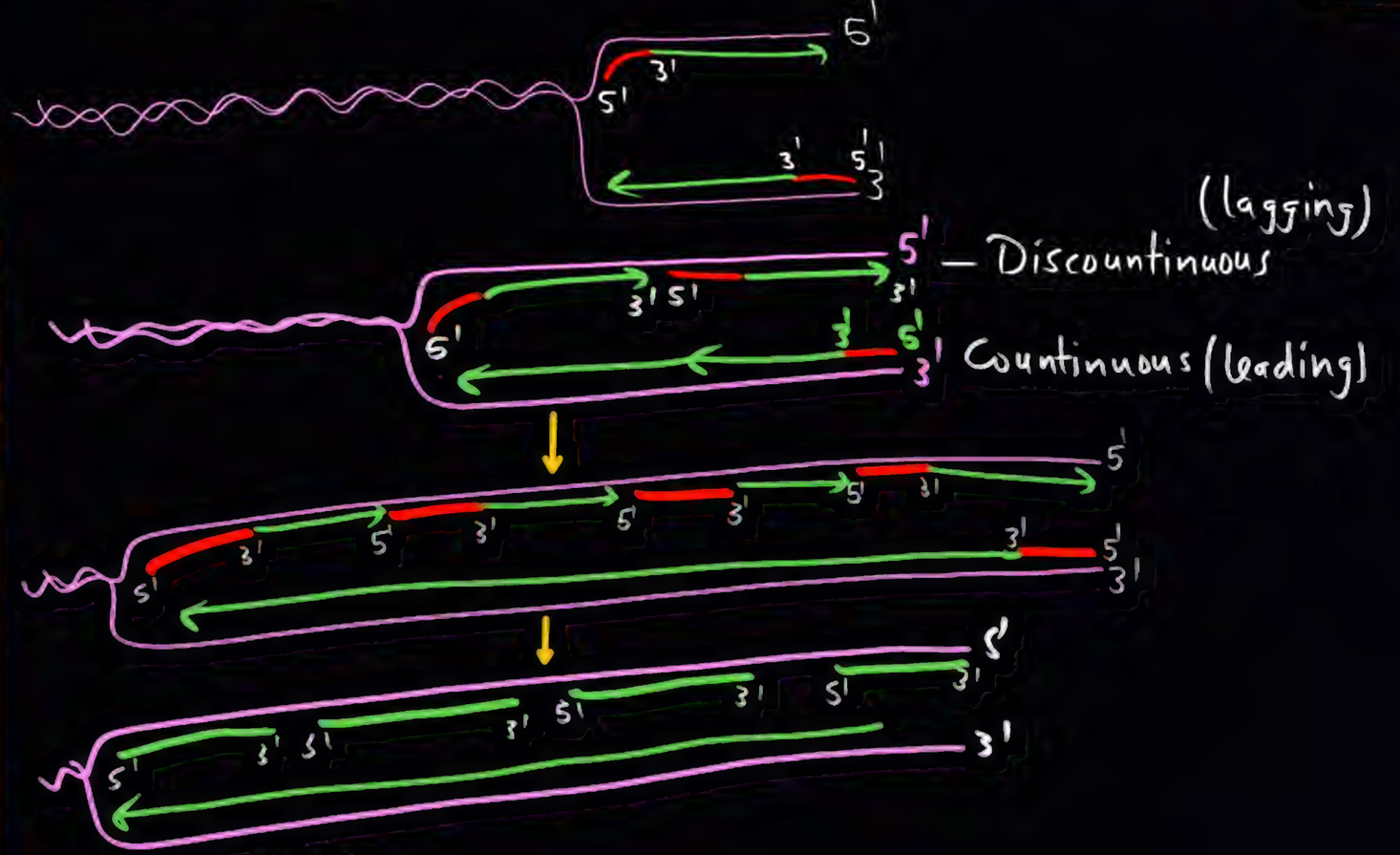
Complete DNA not open at once →



DNA polymerase

– Add one nucleotide at 3' end

So DNA synthesis in 5'–3' Direction



(lagging) – Discountinuous

Countinuous (leading)

Gap is Filled By

Gap is sealed By

Transcription

- Copying information of DNA into RNA
- RNA is copy → not same But Similar

Location – Cytoplasm (Prokaryotes
Nucleus (Eukaryotes
– all DNA not transcribe

$G_1 + S + G_2$ – Phase – Transcription

Both strand not Act as template

(a) if same time occur – ds RNA Form
(b) If Different time occur – two different Protein

steps in transcription

Initiation – RNA polymerase + Sigma Factor
(Recognise Promoter → Small piece of RNA Form

Elongation – Sigma Factor leave
RNA polymerase Act

Termination – RNA polymerase + Rho factor
Recognise terminator Region → RNA leave First

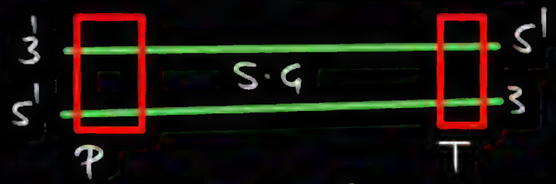
Enzyme leave ← DNA close

Prokaryotes – Cytoplasm, Coupled transcription & translation
Single RNA pol

Eukaryotes → Nucleus, three RNA polymerase

Transcription unit

Independent Event of transcription
T.U – 1 Gene – monocistronic
T.U – Many Gene – Polycistronic



– P – Promoter – transcription start
attach 5'-end upstream – coding strand

T – Terminator – 3'-end downstream – coding strand

Structural Gene – S·G – Template – Actually Function
Coding – code similar to RNA (U in place of T)

Definition – Gene – unit of inheritance
Difficult to define in Sequence

– Gene – code For Any type of RNA
– Cistron those gene code For polypeptide

Prokaryotes → 1 transcription unit – many cistron
Eukaryotes – 1 Transcription unit – Single cistron

Eukaryotes – Split gene – Gene give coding Exon
non-coding intron

↓
Reminiscent of Antiquity

Type of RNA

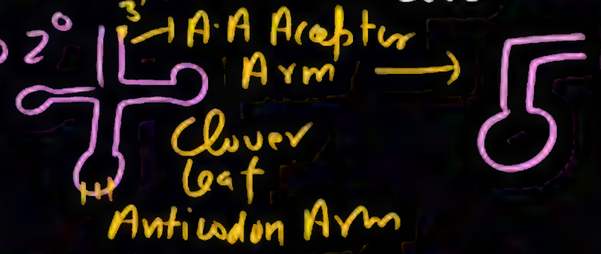
γ RNA – γ ribosomal RNA → Catalyst (Ribozyme) + Structural (most stable Abundant)
t-RNA – transfer RNA, Soluble RNA, Read code on mRNA Bring A.A on Ribosome
hnRNA → modify into mRNA
Sn RNA → Small nuclear RNA
Sc RNA – Small cytoplasmic RNA

Transfer RNA – Soluble, Adapter

Crick – Adapter hypothesis – Amino Acid can not Read code Some Adapter present

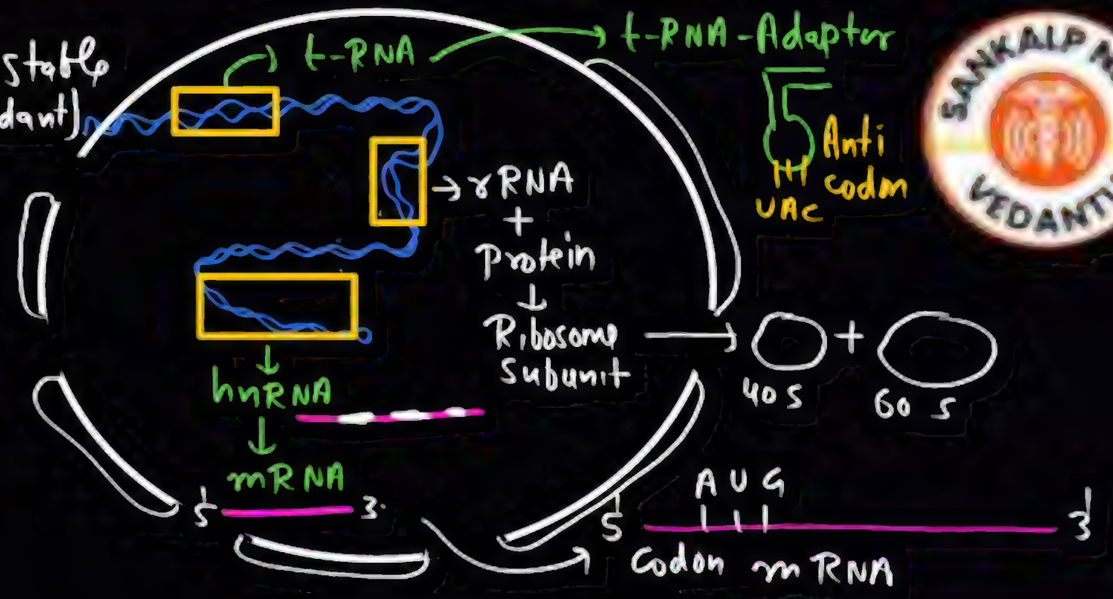
t-RNA Discovered → Genetic code → Role of t-RNA

1° → 2° → 3° (Functional) inverted L-shape



- no t-RNA For stop codon
- Functional is – inverted L-shape
- Different initiator codon

	Prokaryotes	Eukaryotes
RNA polymerase	γ RNA	RNA pol I – γ
	tRNA	RNA Pol II – h
	mRNA	RNA Pol III – t



Ribosomal RNA (γ RNA)

80 S → 60 S → 28 S, 5.8 S, 5 S] 80 type protein
80 S → 40 S → 18 S (nucleolus)

70 S → 50 S → 23 S, 5 S
70 S → 30 S → 16 S

Post transcriptional modification – hnRNA (Less Stable) → PTM → mRNA

Capping – m⁷G 5′ (7-methyl Guanosine tri phosphate)

tailing – AAAA 3′ (200–300 PolyAdenylate)

Intron – not come in Processed RNA

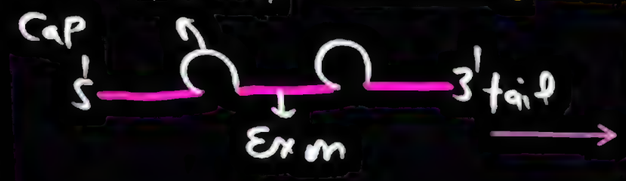
Exon – come in processed RNA

Smallest – tRNA

Stability → rRNA > tRNA > mRNA > hnRNA

Amount → rRNA > tRNA > mRNA

splicing [Removal of intron & linking of Exon



→ 5′ — mRNA — 3′ (smaller than hnRNA)

(Use in Reverse transcription)

Genetic code

DNA Replication, transcription – Complimentary Base pairing

Translation – no such Relation

deciphering – How much nucleotide – 1 A·A which set of nucleotide For which A·A

(Organic chemist, Biochemist, Geneticist, Physicist)

George Gamow – Genetic code triplet

4^1 = 4 code 4^2 = 16 code 4^3 = 64 code ✱

Severo ochoa

Nirenberg

H. G Khorana

Salient Feature

(a) Triplet

(b) AUG – start codon – Dual Role (start & mid)

UGA, UAG, UAA } – stop codon

(c) Without punctuation

(d) Universal (Except – some protozoa, Mitochondria

(e) degenrate

✱ Unambiguous

Mutation ⟶ substitution – One A·A change

Deletion & Addition – FRAME shift

RAM HAS RED CAP

Translation – location – Cytoplasm

Charging of t-RNA

Amino Acid + ATP → Amino AcylPAMP

Amino Acyl AMP → Charge t-RNA + AMP
+ t RNA

Enzyme –

Steps

(a) mRNA + Small Subunit

(b) t-RNA at P-site

(c) large Subunit

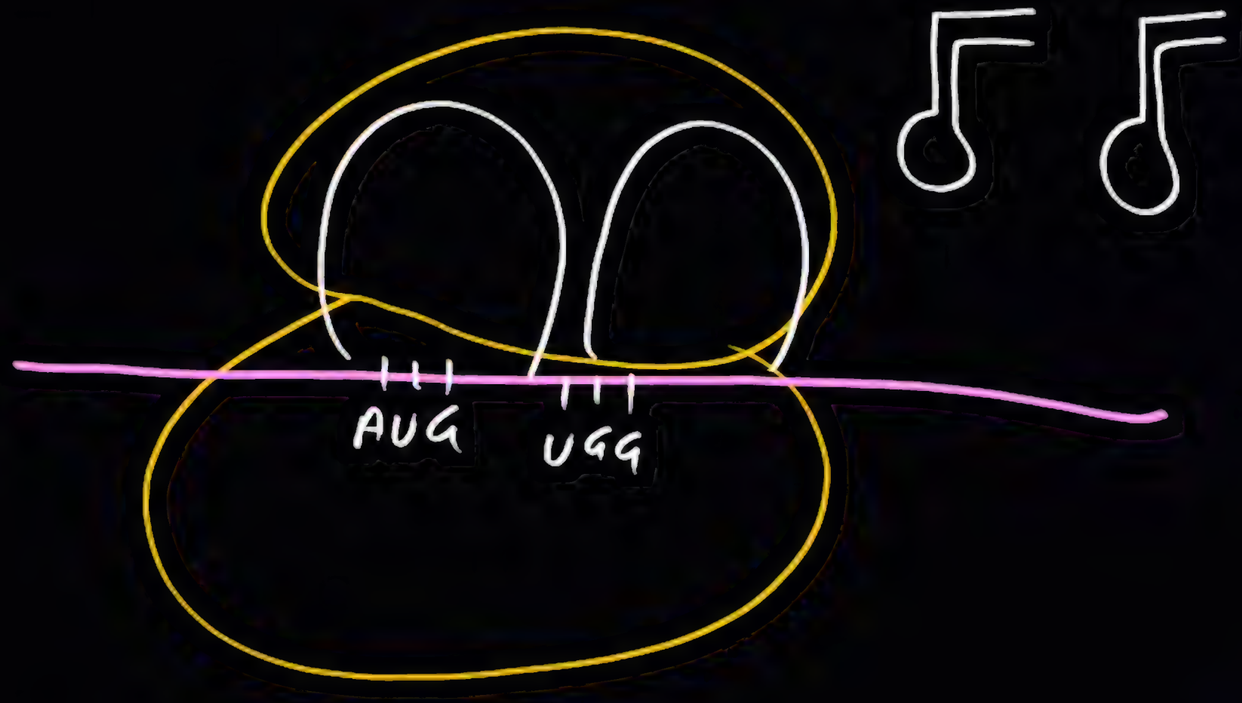
(d) Charge t-RNA at - A site

(e) Peptide Bond Form

(f) t-RNA Empt at P-site move out

(g) Ribolome move Forward

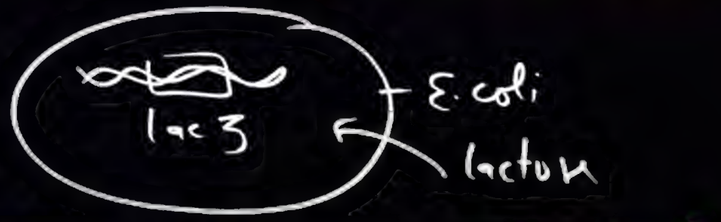
(h) Stop codon at A-site
no t-RNA → Release Factor At



Regulation of Gene Expression

Need - Metabolic, Development, Environment

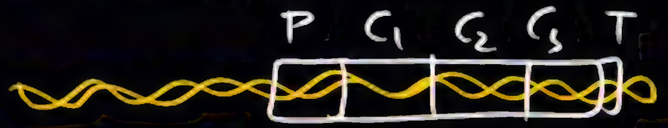
Levels - Transcription
- PTM
- Transport
- Translation

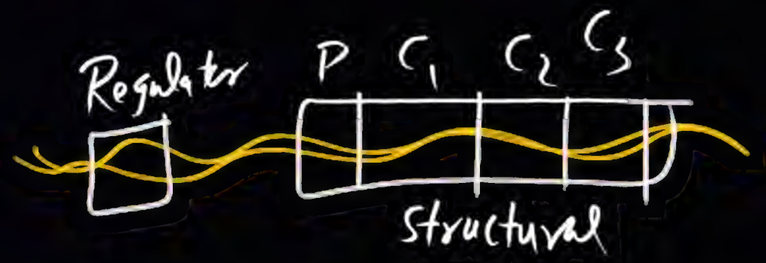


Type of Gene — Structural
Regulator

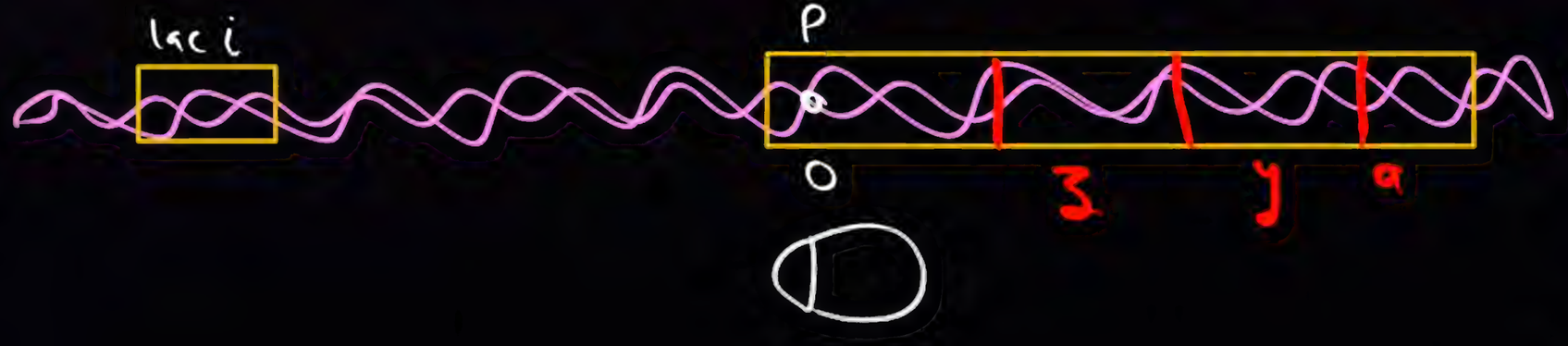
Constitutive
non-constitutive

Concept of Operon



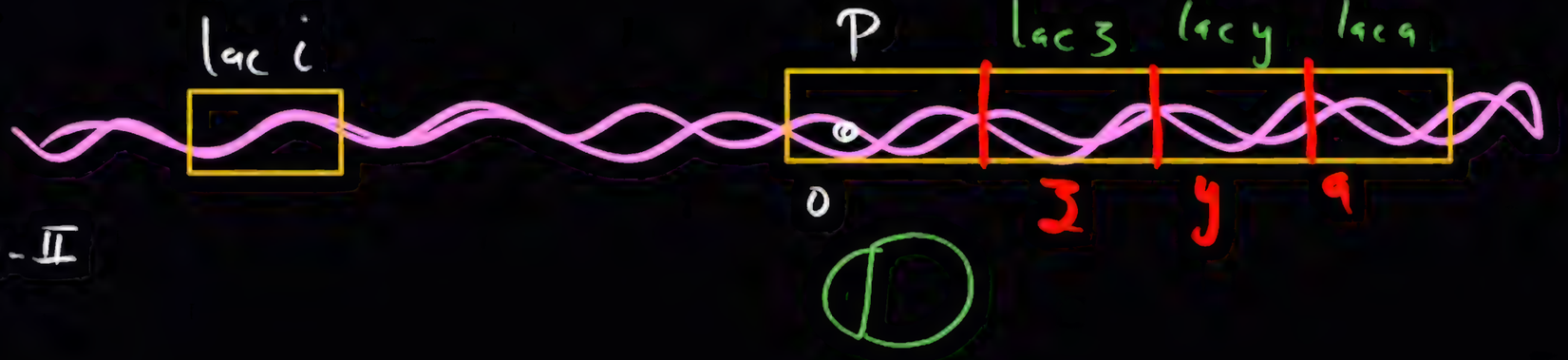


galactosidase
Permease
transacetylase



Case - I

z	
y	
a	



Case - II

MANTHAN NEET 2025 1.0 to 2.0

SANKALP NEET VEDANTU

Molecular Basis of inheritance

lecture –03

Botany

TARUN SIR

Topic

structure of nucleic Acid ✓ (Biomolecule) Question - 7

Discovery of DNA ⟶

Watson and crick model ⟶

Packaging of DNA ⟶

Search of Genetic material → (Experiments)

DNA Replication (Experiment, Process)

Transcription – Process

Type of RNA →

Genetic code →

Translation →

Gene Expression →

Human Genome project →

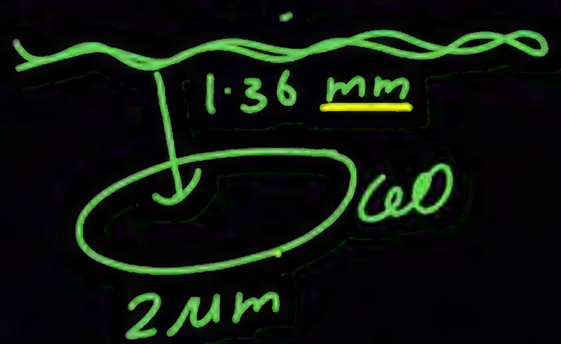
DNA fingerprinting →

Packaging of DNA

- DNA length → larger than the length of cell
- DNA need to be packaged/Fold – so that it can be kept in cell

Prokaryotic cell (E. coli.)

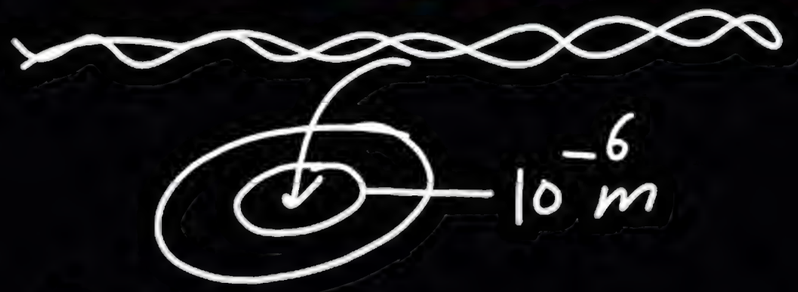
4.6×10^6 Bp $\times 0.34$ nm = 1.36 mm DNA



Eukaryotic cell (Human cell)

3.3×10^9 Bp (haploid) $\times$ 0.34 nm = 1.1 meter (Sperm)

6.6×10^9 Bp (Diploid) $\times$ 0.34 nm = 2.2 meter (Skin)



S-I Prokaryotic cell show packaging of DNA

S-II Eukaryotic cell show packaging of DNA (Both correct)

5.1.2 Packaging of DNA Helix

Taken the distance between two consecutive base pairs as 0.34 nm (0.34×10^{-9} m), if the length of DNA double helix in a typical mammalian cell is calculated (simply by multiplying the total number of bp with distance between two consecutive bp, that is, 6.6×10^{9} bp × 0.34×10^{-9} m/bp), it comes out to be approximately 2.2 metres. A length that is far greater than the dimension of a typical nucleus (approximately 10^{-6} m). How is such a long polymer packaged in a cell?

Prokaryotic cell Packaging

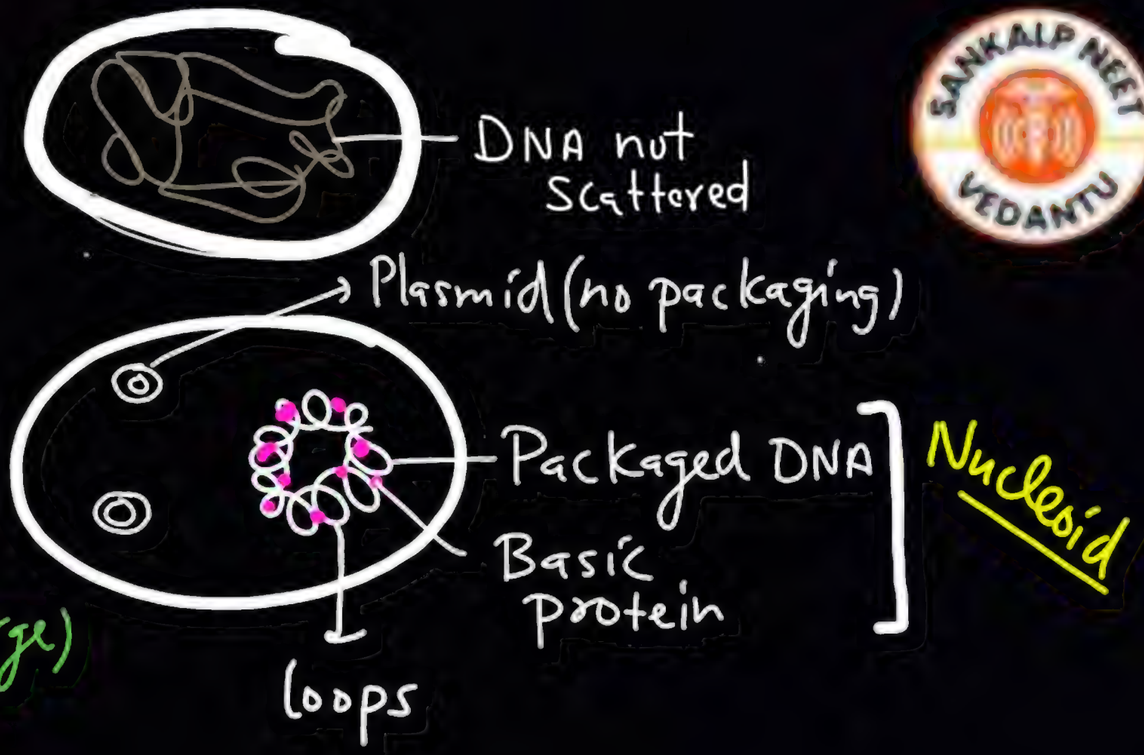
→ Prokaryotic cell → DNA in Cytoplasm

→ DNA not scattered in Entire Cytoplasm

→ DNA Packaged with the help of Basic protein (+ve charge)

– DNA from Large loops held By Protein (+ve charge)

– Packaged DNA is nucleoid

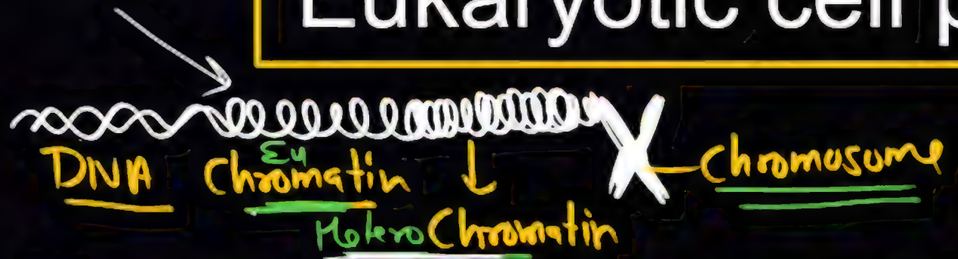


Q Chromatin not present in
(1) Yeast (2) E. coli (3) Mammelian cell (4) Skin cell

Prokaryotic cell

In prokaryotes, such as, *E. coli*, though they do not have a defined nucleus, the DNA is not scattered throughout the cell. DNA (being negatively charged) is held with some proteins (that have positive charges) in a region termed as 'nucleoid'. The DNA in nucleoid is organised in large loops held by proteins.

Eukaryotic cell packaging



Human → Diploid cell DNA — 2·2 meter
→ 10^{-6} m Size nucleus have Such DNA

Chromatin condense DNA (less space)
G_1 S G_2
Permanent

G_1 S G_2 → Chromatin present

M-phase – Chromosome present
(Only in Dividing)

Package DNA in Form of chromatin get open in form of DNA (all DNA not get open together)

G_1 & G_2 → DNA open For transcription
S-phase → DNA open For Replication

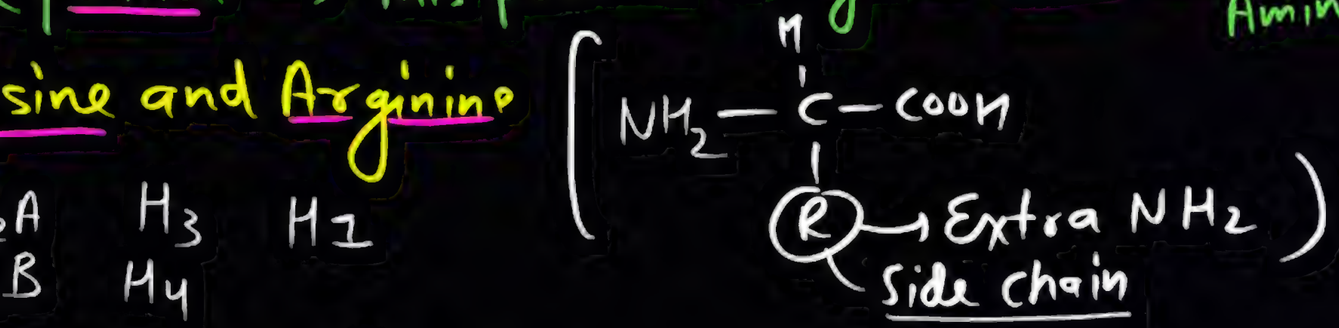
Q Most condense From of DNA present in
(a) Apical meristem (b) Guard cell (c) Epidermis (d) Nucellus
(M-phase)

Detail of packaging in Eukaryotes

For packaging histones involve

Histones → Basic protein/charge positive → This positive charge is Due to Basic Amino Acid

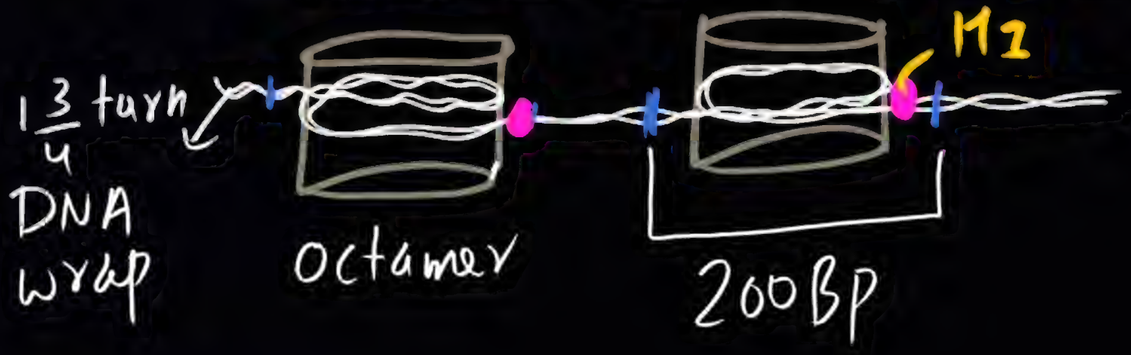
→ Histones Rich in Lysine and Arginine

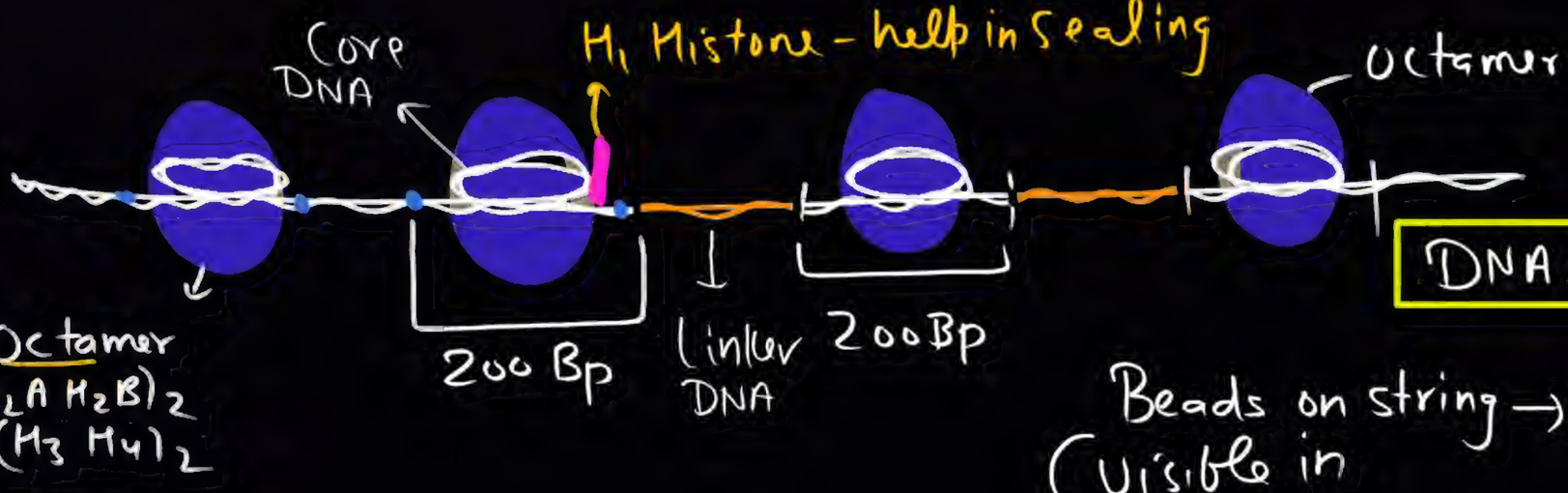


Type of Histones – Five → H_2A H_2B H_3 H_4 H_1

→ Octamer → total 8 Histones/4 type

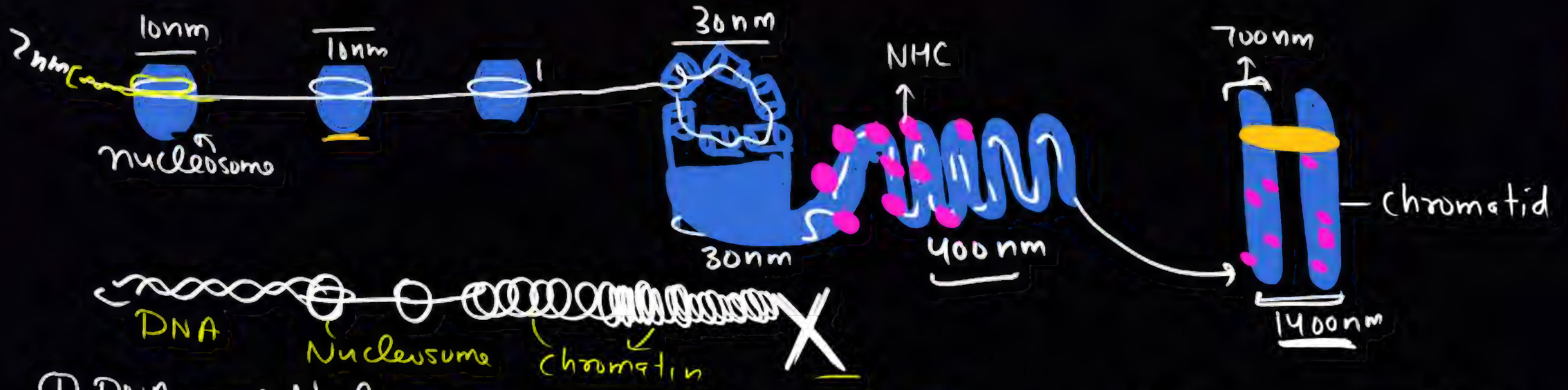
– Histone Octamer – on which DNA (–ve charge – Due to phosphate) Wrap ($1\frac{3}{4}$ turn → 200 BP)





DNA + octamer = Nucleosome

Beads on string → String = DNA
(Visible in EM)
Beads → Nucleosome



① DNA (2nm) → Nucleosome (Histone) 10nm → 30nm → 400nm → 700nm (Chromatid) → 1400 Chromosome

(M-Phase)

(Histone - help in initial level Packaging)

Chromatin (Higher level Packaging → Non-Histone chromosomal Protein (NHCs))

Euchromatin
- less condensed
- light stain
- transcriptionally active

Heterochromatin
- More condensed
- Dark stain
- Transcriptionally inactive

Q Gene Active in
(a) Euchromatin →
(b) Heterochromatin
(c) chromosome
(d) all

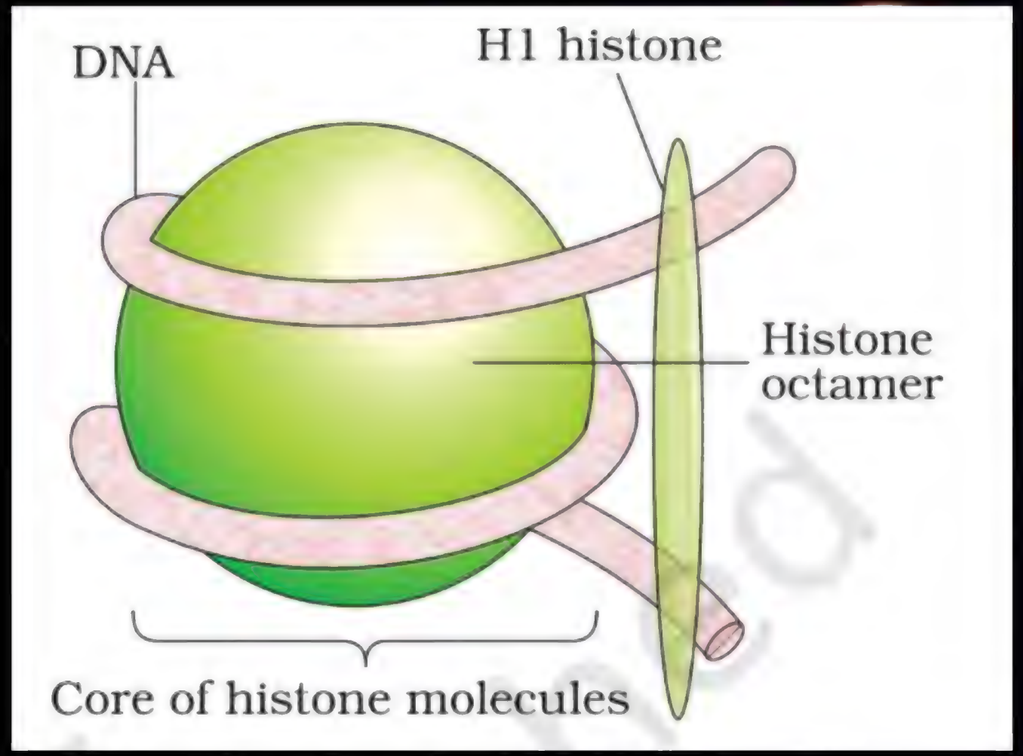
Eukaryotic cell packaging

In eukaryotes, this organisation is much more complex. There is a set of positively charged, basic proteins called **histones**. A protein acquires charge depending upon the abundance of amino acids residues with charged side chains. Histones are rich in the basic amino acid residues lysine and arginine. Both the amino acid residues carry positive charges in their side chains. Histones are organised to form a unit of eight molecules called **histone octamer**.

Figure 5.4b EM picture -

200 Bp X 0·34nm = 68nm

The negatively charged DNA is wrapped around the positively charged histone octamer to form a structure called **nucleosome** (Figure 5.4 a). A typical nucleosome contains 200 bp of DNA helix. Nucleosomes constitute the repeating unit of a structure in nucleus called **chromatin**, thread-like stained (coloured) bodies seen in nucleus. The nucleosomes in chromatin are seen as 'beads-on-string' structure when viewed under electron microscope (EM) (Figure 5.4 b).


DNA
H1 histone
Histone octamer
Core of histone molecules

Theoretically, how many such beads (nucleosomes) do you imagine are present in a mammalian cell?

The beads-on-string structure in chromatin is packaged to form chromatin fibers that are further coiled and condensed at metaphase stage of cell division to form chromosomes. The packaging of chromatin at higher level requires additional set of proteins that collectively are referred to as

Non-histone Chromosomal (NHC) proteins. In a typical nucleus, some region of chromatin are loosely packed (and stains light) and are referred to as **euchromatin**. The chromatin that is more densely packed and stains dark are called as **Heterochromatin**. Euchromatin is said to be transcriptionally active chromatin, whereas heterochromatin is inactive.

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Molecular Basis of inheritance

lecture –04

Botany

TARUN SIR

Topic

structure of nucleic Acid ✓ (Biomolecule) Question → 7

Discovery of DNA →

Watson and crick model →

Packaging of DNA →

Search of Genetic material → (Experiments)

DNA Replication (Experiment, Process)

Transcription — Process

Type of RNA →

Genetic code →

Translation →

Gene Expression →

Human Genome project →

DNA fingerprinting →

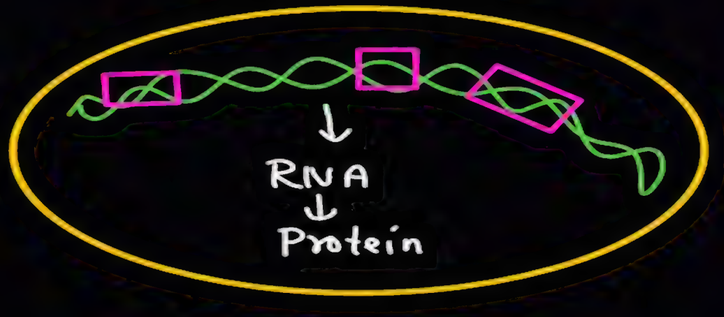
cell theory

What is Genetic material

Genetic material have →

Feature – (a) Carry information

(b) Pass on to next generation



SANKALP NEET VEDANTU

Search of Genetic material

* Mendel work, Chromosomal theory
  Linkage ⟶ Anything which control inheritance
  inside nucleus ⟶ Related to chromosome
* 1926 ⟶ Quest to determine Chemical nature of Genetic Material | molecular level search of Genetic material Started

Meischer (1869)
(nuclein)

1926

Experiments to determine Chemical nature

1952, Genetic material

Watson & Crick - 1953
(DNA structure Model)

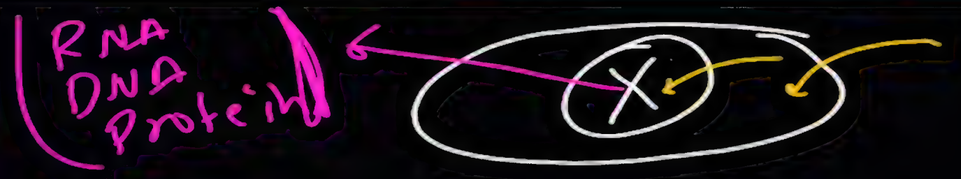
(1865)
Mendel
↓
→ Meiosis
→ Mendel work Rediscovery
→ Chromosomal theory
↓
Morgan
(Linkage)
1910
(Chromosomal level (limit)

5.2 The Search for Genetic Material

1869

Even though the discovery of nuclein by Meischer and the proposition for principles of inheritance by Mendel were almost at the same time, but that the DNA acts as a genetic material took long to be discovered and proven. By 1926, the quest to determine the mechanism for genetic inheritance had reached the molecular level. Previous discoveries by Gregor Mendel, Walter Sutton, Thomas Hunt Morgan and numerous other scientists had narrowed the search to the chromosomes located in the nucleus of most cells. But the question of what molecule was actually the genetic material had not been answered.

1865



I Griffith Experiment / Transformation Experiment Year – 1928

→ Bacteria → Streptococcus pneumoniae (Cause pneumonia)
Pneumonococcus

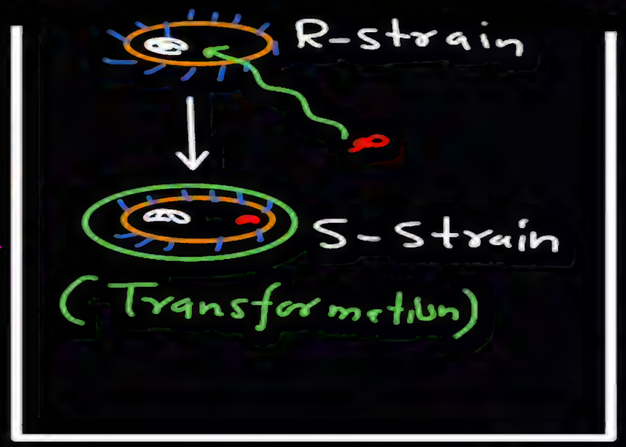
Two strain of this Bacteria →

R-strain → Rough → host (mice) Immune system detect → R-strain not Cause Pneumonia – non-virulent

Mucus coat (Mucopolysaccharide) → S-strain → Smooth or shiny colony in plate – Pneumonia cause – virulent (Disease Causing)

- Griffith Study → Some Material From medium
Miraculous transformation of R strain → S-strain

Change in Physical Form / Change in phenotype



Plate

Experiment

1. R strain → inject in mice → mice alive
   Reason: R-strain non virulent
2. S strain → inject in mice → mice killed
   Mice killed due to Pneumonia (S-strain virulent)
3. Heat killed S strain → inject in mice → mice alive
   → Heat can stop multiplication of S-strain
4. Heat killed S strain + Live R-strain → inject in mice → Mice killed
   → From killed Mice Live S-strain

Conclusion:- Something From Heat Killed S-strain tranform R-strain into S-strain

- Griffith named it as tranforming principle
- Chemical nature of tranforming principle unknown

Transforming Principle

In 1928, Frederick Griffith, in a series of experiments with *Streptococcus pneumoniae* (bacterium responsible for pneumonia), witnessed a miraculous transformation in the bacteria. During the course of his experiment, a living organism (bacteria) had changed in physical form.

When *Streptococcus pneumoniae* (pneumococcus) bacteria are grown on a culture plate, some produce smooth shiny colonies (S) while others produce rough colonies (R). This is because the S strain bacteria have a mucous (polysaccharide) coat, while R strain does not. Mice infected with the S strain (virulent) die from pneumonia infection but mice infected with the R strain do not develop pneumonia.

S strain → Inject into mice → Mice die

R strain → Inject into mice → Mice live

Griffith was able to kill bacteria by heating them. He observed that heat-killed S strain bacteria injected into mice did not kill them. When he

S strain (heat-killed) → Inject into mice → Mice live

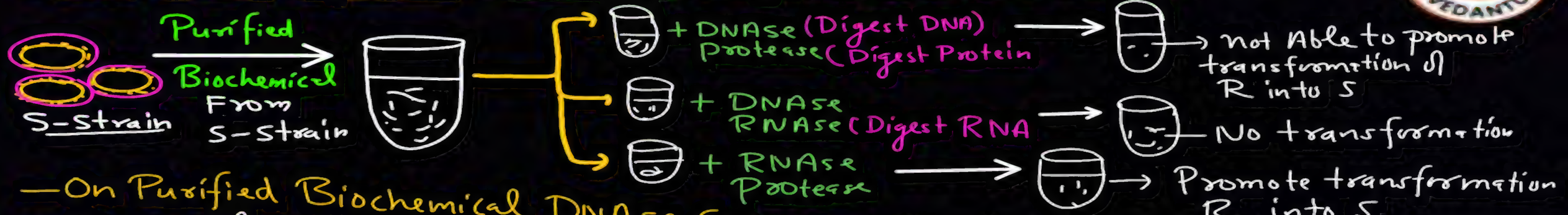
S strain (heat-killed) + R strain (live) → Inject into mice → Mice die

injected a mixture of heat-killed S and live R bacteria, the mice died. Moreover, he recovered living S bacteria from the dead mice.

He concluded that the R strain bacteria had somehow been **transformed** by the heat-killed S strain bacteria. Some 'transforming principle', transferred from the heat-killed S strain, had enabled the R strain to synthesise a smooth polysaccharide coat and become virulent. This must be due to the transfer of the genetic material. However, the biochemical nature of genetic material was not defined from his experiments.

Avery Macleod McCarty – 1944

– Prior to their Experiment – Protein was thought to be Genetic material



– On Purified Biochemical DNAse Enzyme → No tranfromation

– On purified Biochemical → RNAse & Protease → Transformation occured

– DNA is Transforming principle

– Many Scientist not convinced → DNA is Genetic material.

DNA – nucleic Acid
DNAse → Enzyme

Biochemical Characterisation of Transforming Principle

Prior to the work of Oswald Avery, Colin MacLeod and Maclyn McCarty (1933-44), the genetic material was thought to be a protein. They worked to determine the biochemical nature of 'transforming principle' in Griffith's experiment.

They purified biochemicals (proteins, DNA, RNA, etc.) from the heat-killed S cells to see which ones could transform live R cells into S cells. They discovered that DNA alone from S bacteria caused R bacteria to become transformed.

They also discovered that protein-digesting enzymes (proteases) and RNA-digesting enzymes (RNases) did not affect transformation, so the transforming substance was not a protein or RNA. Digestion with DNase did inhibit transformation, suggesting that the DNA caused the transformation. They concluded that DNA is the hereditary material, but not all biologists were convinced.

Can you think of any difference between DNAs and DNase?

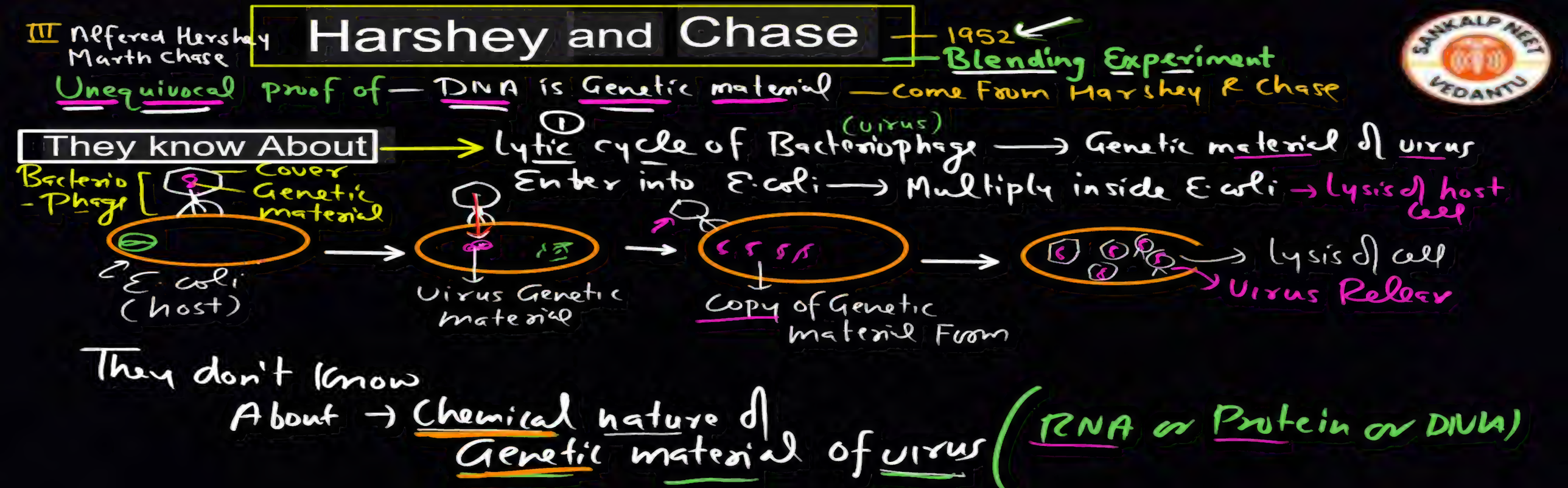
	year	organism used	conclusion
Griffith	1928 Transformation Experiment	Streptococcus Mice	Tranforming Principle (Unknown) ⟶ Tranform R into S
Macleod Avery McCarty	1944	Streptococcus	– RNAse & Protease not inhibit transformation – DNAse inhibit transformation – DNA is Transforming principle
Harshey and Chase	1952		

Harshey and Chase

III Alfered Hershey
Marth Chase

1952
Blending Experiment

Unequivocal proof of — DNA is Genetic material — come From Harshey & Chase



They don't know
About → Chemical nature of Genetic material of virus (RNA or Protein or DNA)

- Virus is made up of Protein & DNA ⟶ Harshey & Chase (Know this)
- Harshey and chase they don't Know About ⟶ Genetic material which Enter is DNA or Protein

- Use Radioactive ⟶ Sulfur → S^{35} → Part of Protein → (to Grow Virus) → Virus – Radioactive Sulfur in protein

→ Phosphorus → P^{32} → part of DNA → on which Virus Grow (now he obtain virus with Radioactive DNA Virus Radioactive DNA

→ Finally two type of virus ⟶ Protein Radioactive (S^{35})
DNA Radioactive (P^{32})

steps of Experiment (Blending)

} Radioactive Sulfur (Protein Radioactive)

(a) Infection →

(Virus Genetic material Enters

(b) Blending →

(c) Centrifugation →

Supernatant → Cover of virus

Pellet (Heavy) → host cell with Genetic material of Virus

(S^{35})

When Protein Radioactivity → Radioactivity Come From Supernant

} Radioactive Phosphorus (DNA Radioactive)

(a)

(b) Blending → Cover virus Seperate From E coli host cell

(c) Centrifugation

→ When DNA Radioactive (P^{31}) Radioactivity From pellet

→ Radioactivity coming From Genetic Material of virus

→ Genetic material of virus is DNA

Pellet Radioactive.

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Molecular Basis of inheritance

lecture-05

Botany

TARUN SIR

Topic

structure of nucleic Acid ✓ (Biomolecule) Question - 7

Discovery of DNA →

Watson and crick model →

Packaging of DNA →

Search of Genetic material → (Experiments)

DNA Replication (Experiment, Process)

Transcription – Process

Type of RNA →

Genetic code →

Translation →

Gene Expression →

Human Genome project →

DNA fingerprinting →

Why DNA is Genetic material

- Experiments proof DNA is Genetic material – Harshey and chase Experiment
- Some virus – RNA is Genetic material
  Ex – TMV (tobacco mosaic virus) Qβ Bacteriophage – RNA as genetic material
  – This means (RNA) can also act as genetic material
  – But why nature Selected DNA ?? ?

Good Genetic material – 4 Feature

(a) Stability – Chemical & structural stability

(b) Able to make Replica (Copy Form)

(c) Undergo slow mutation (Variation occur)

(d) Show mendelian pattern of Expression (Genetic material ⟶ trait Express) Any

5.2.2 Properties of Genetic Material (DNA versus RNA)

Hershey & Chase → Protein X
DNA

From the foregoing discussion, it is clear that the debate between proteins versus DNA as the genetic material was unequivocally resolved from Hershey-Chase experiment. It became an established fact that it is DNA that acts as genetic material. However, it subsequently became clear that

A molecule that can act as a genetic material must fulfill the following criteria:

(i) It should be able to generate its replica (Replication).

(ii) It should be stable chemically and structurally.

(iii) It should provide the scope for slow changes (mutation) that are required for evolution.

(iv) It should be able to express itself in the form of 'Mendelian Characters'.

If one examines each requirement one by one, because of rule of base pairing and complementarity, both the nucleic acids (DNA and RNA) have the ability to direct their duplications. The other molecules in the living system, such as proteins fail to fulfill first criteria itself.

I structurally and chemical stable

Structural stability → DNA → Double strand, H-Bond → More stable
RNA – Single strand → less stable →

(DNA is structurally stable to high temp → In Griffith Experiment
Heat kill S-strain But DNA stability remain as such (thermostable)

Chemical stability

(a) DNA never Act as catalyst, Some RNA Act as Catalyst
(to Act as catalyst, Reactivity Require)

(b) RNA have most Reactive Base → Uracil
DNA have thymine (less Reactive)
(Uracil modified into t-RNA as Dihydrouridine & Pseudouridine)

(c) Ribose Sugar in RNA → have 2'-OH (make it labile (prone) to Digestion (Break down)

(RNA virus ⟶ mutate Fast → RNA is not much stable)
Ex- Covid virus

(DNA is stable → not show much change – During cell Division (life cycle)
Due to Environment

The genetic material should be stable enough not to change with different stages of life cycle, age or with change in physiology of the organism. Stability as one of the properties of genetic material was very evident in Griffith's 'transforming principle' itself that heat, which killed the bacteria, at least did not destroy some of the properties of genetic material. This now can easily be explained in light of the DNA that the two strands being complementary if separated by heating come together, when appropriate conditions are provided. Further, 2′-OH group present at every nucleotide in RNA is a reactive group and makes RNA labile and easily degradable. RNA is also now known to be catalytic, hence reactive. Therefore, DNA chemically is less reactive and structurally more stable when compared to RNA. Therefore, among the two nucleic acids, the DNA is a better genetic material.

II Able to make Replica → DNA and RNA Both are nucleic Acid

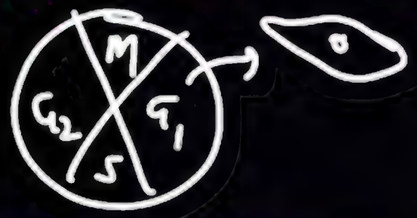
Nucleic Acid property → it can make copy By complimentary Base pairing

(DNA and RNA Both can make copy)

III Slow mutation → DNA stable → slowly mutate (Even if change occur) (Further proof reading and DNA Damage Repair not Allow much change)

RNA mutate fast (Unstable), no proofreading and not Any Repair

(DNA is Better to store Any Genetic information)



IV Express in mendelian pattern ⟶ For Expression of trait RNA is Better

DNA ⟶ RNA ⟶ Protein → trait Express

DNA Express trait through RNA

- Storage of Genetic information – DNA is Better than RNA
- trait Express → RNA Better

In fact, the presence of thymine at the place of uracil also confers additional stability to DNA. (Detailed discussion about this requires understanding of the process of repair in DNA, and you will study these processes in higher classes.)

Both DNA and RNA are able to mutate. In fact, RNA being unstable, mutate at a faster rate. Consequently, viruses having RNA genome and having shorter life span mutate and evolve faster.

RNA can directly code for the synthesis of proteins, hence can easily express the characters. DNA, however, is dependent on RNA for synthesis of proteins. The protein synthesising machinery has evolved around RNA. The above discussion indicate that both RNA and DNA can function as

genetic material, but DNA being more stable is preferred for storage of genetic information. For the transmission of genetic information, RNA is better.

What is RNA world

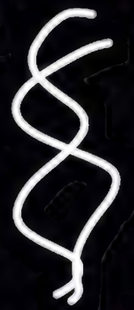
- First Genetic material is RNA or DNA
- Sufficient Evidence to Support RNA was First Genetic material

(a) RNA act as catalyst
(Ribosome - 23 s rRNA Act as a Enzyme to make peptide Bond B/w two Amino Acid)

(b) RNA Act as messenger, Adapter (t RNA)

(c) RNA Perform splicind

DNA



To increase stability
RNA show Changes

(a) chemical change
- (U ⟶ T)
- 2'-OH ⟶ 2'-H Sugar

(b) Structural change
(Single Strand to Double Strand)

RNA Evolve First ⟶ Problem - Unstable (RNA)

- Act as messenger - to provide code
- Act as catalyst
- Processing of other RNA (Splicing)

all Functim to make protein

DNA Replication

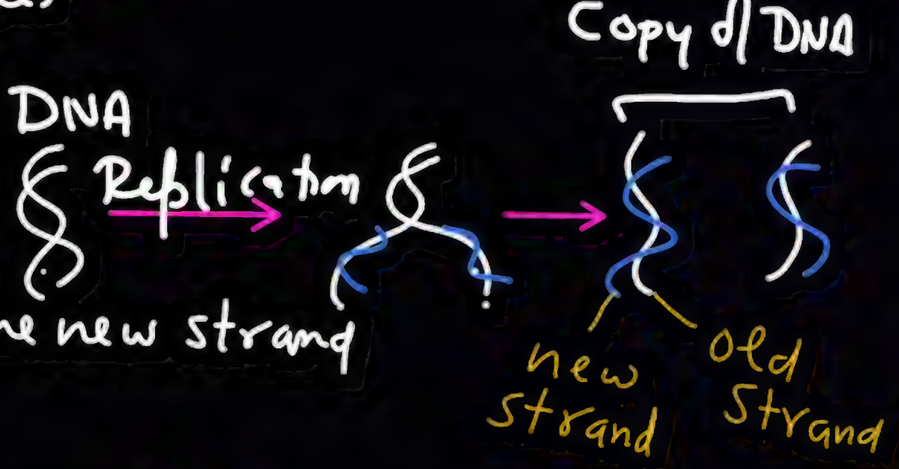
Central Dogma (Crick)

DNA → mRNA → Protein

meaning — making copy of DNA (Eukaryotes — S-phase
Prokaryotes — Prior to Fission)

Basics → location → Nucleus (Eukaryotes) , Organelles
Cytoplasm (Prokaryotes)

- DNA Replication — (a) Semi conservative
(two copy of DNA - one old strand and one new strand



topics

1. Experiment - To proof DNA Replication is Semi conservative
2. Process → Basics
→ Steps in DNA Replication

Semiconservative DNA Replication

→ 1953 → Watson and Crick model ⟶ main point 'Complimentary Base pairing'

(Complimentary Base pairing ⟶ they can predict Possible mode of DNA Replication

DNA ⟶ DNA open ⟶ new strand Form ⟶

Each copy new strand and one old strand → Complimentary Base pairing

Experiments to Prove DNA Replication is Semiconservative → First in E. coli (Bacteria) Plants, Animals

(First Experiment – Messelson & Stahl – Experimental proof

scientist	year	on organism	Material used
(a) Messelson & Stahl Experiment	1958	E. coli (Bacteria)	E. coli grow on NH_4Cl (Source of nitrogen) Enter into DNA
(b) Taylor & other	1958	Vicia Faba (Faba bean)	Plant → DNA Replication study By Using Radioactive thymidine

5.4 Replication

While proposing the double helical structure for DNA, Watson and Crick had immediately proposed a scheme for replication of DNA. To quote their original statement that is as follows:

"It has not escaped our notice that the specific pairing we have postulated immediately suggests a possible copying mechanism for the genetic material" (Watson and Crick, 1953).

The scheme suggested that the two strands would separate and act as a template for the synthesis of new complementary strands. After the completion of replication, each DNA molecule would have one parental and one newly synthesised strand. This scheme was termed as **semiconservative** DNA replication (Figure 5.6).

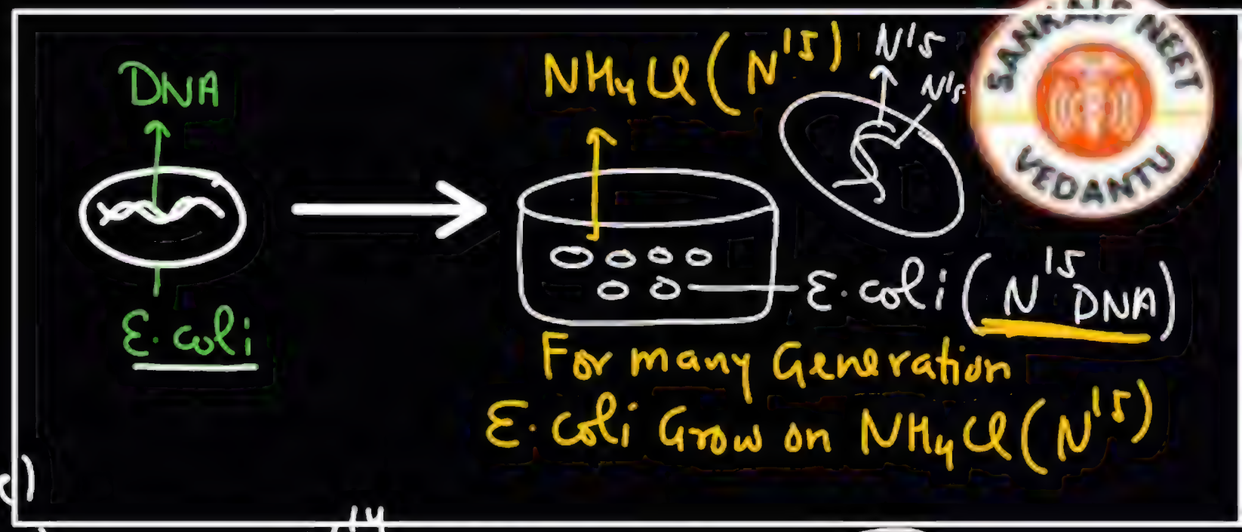
Messelson and stahl

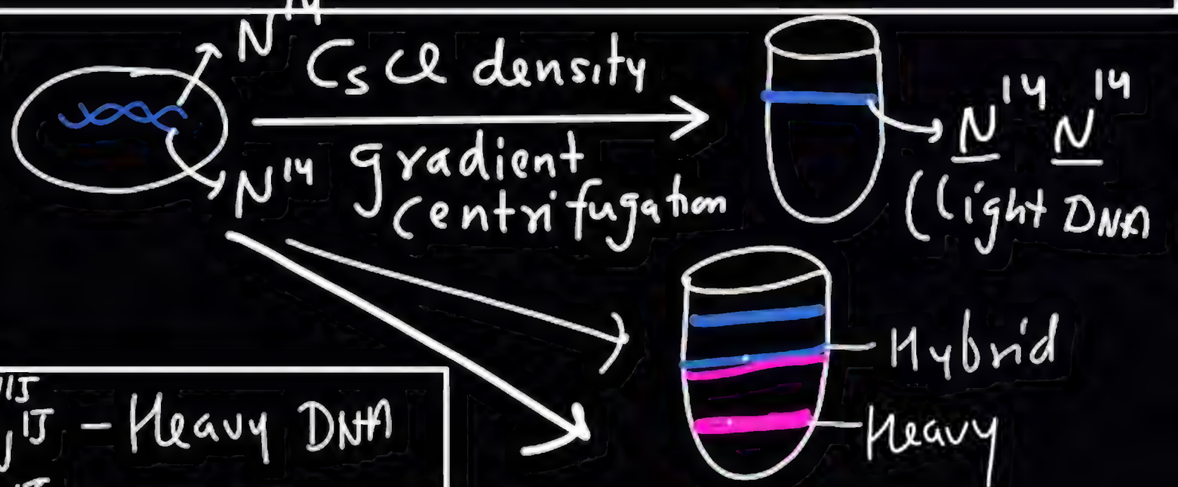
- E.coli Grow on NH_4Cl (Source of Nitrogen)
- When cell Multiply, then NH_4Cl nitrogen Enter into DNA

(Nitrogen → N^{14} – normal – normal Isotope)
→ N^{15} – Heavy Nitrogen / Heavy isotope)
↳ Enter into DNA – Density more)

- E.coli → DNA → Centrifuge ($CsCl$)

DNA with Different in density seperate



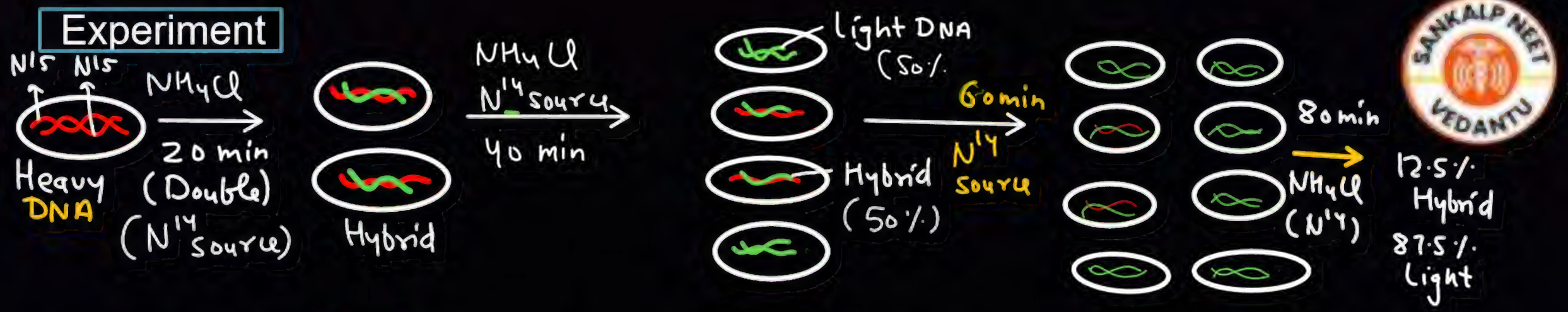


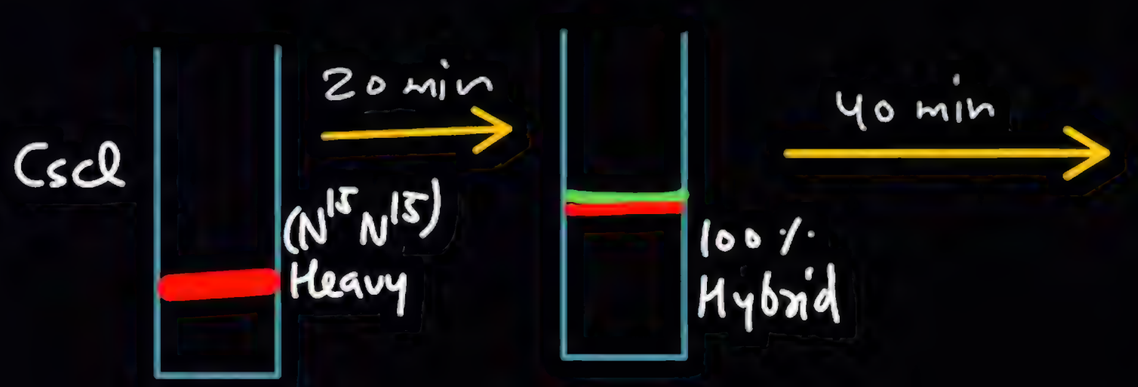
N^{15}
N^{15} – Heavy DNA

N^{15}
N^{14} → Hybrid DNA

N^{14}
N^{14} → Light DNA

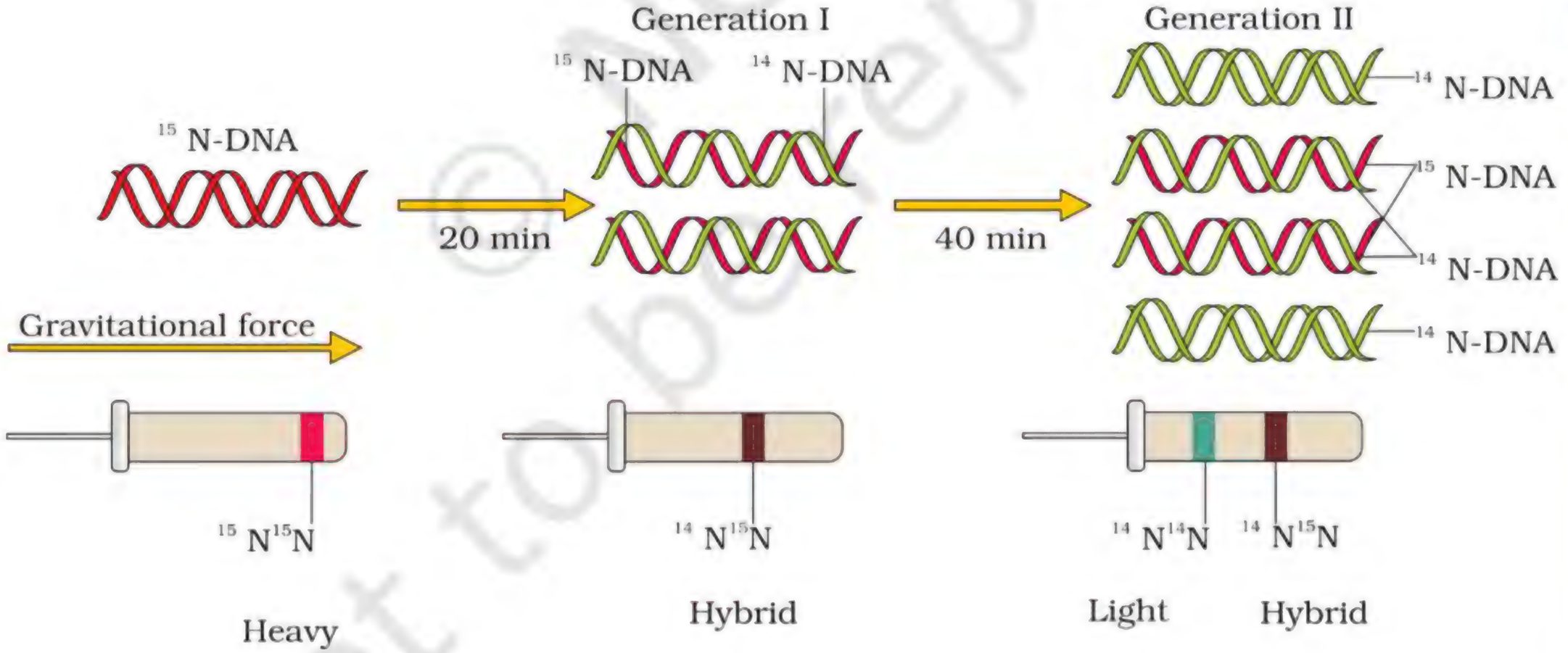
Experiment





* After 20 min → Hybrid Form
* After 40 min → Equal % age of Hybrid & Light
* After 80 min → 75% Light
  25% Hybrid

Hybrid became Zero – NO



(Separation of DNA by Centrifugation)

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Molecular Basis of inheritance

Lecture - 06

Botany

TARUN SIR

Topic

structure of nucleic Acid ✓ (Biomolecule) Question - 7

Discovery of DNA →

Watson and crick model →

Packaging of DNA →

Search of Genetic material → (Experiments)

DNA Replication (Experiment, Process)

Transcription – Process

Type of RNA →

Genetic code →

Translation →

Gene Expression →

Human Genome project →

DNA fingerprinting →

DNA Replication

Basic Feature

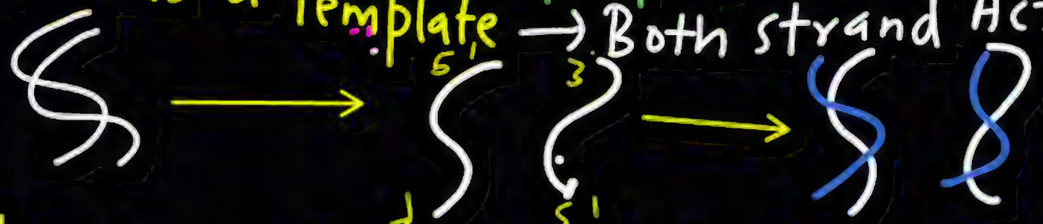
(1) In Eukaryotes – Cell Dividing ⟶ S-phase occur inside nucleus

– Mitochondria & chloroplast
(Matrix) (Stroma)

(2) Prokaryotes S-phase Absent ⟶ DNA Replication
(Ex – E. coli cell Divide into 20 min, DNA Double in 18 min)

NEET 2018
Prior to Fission

(3) Main Enzyme – DNA polymerase
(Use DNA as a template ⟶ Both strand Act as templat



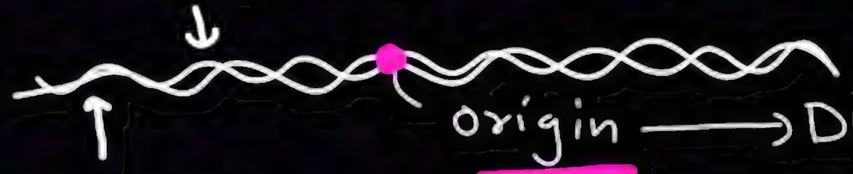
Q Cytoplasmic DNA polymerase
(a) Yeast (b) Root Meristem
(c) E. coli (d) Bone marrow cell

DNA polymerase ⟶ DNA Dependent DNA polymerase

(Substrate ⟶ dNTP (dATP, dGTP, dCTP, dTTP) – deoxynucleoside triphosphate

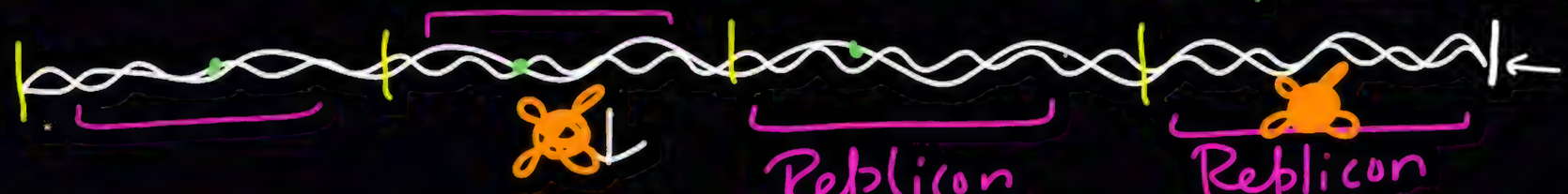
(4) DNA Replication is Semi conservative ⟶ Two Daughter DNA (Old strand one new strand)

(5) DNA Replication start From origin of Replication (Bacteria - origin is ori)



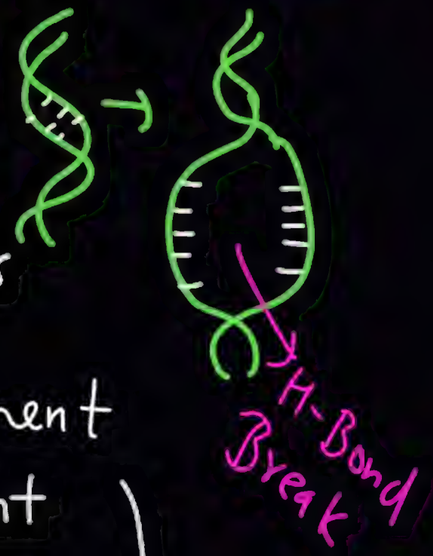
(meaning → H-Bond Break ($2^{\circ} \longrightarrow 1^{\circ}$))

(6) DNA Replication in EuKaryotes occur in Independent units ⟶ Replicons



↓

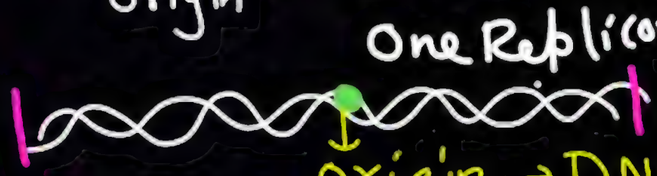
Small segment independent Event of DNA Replication



Concept of Replicon origin Bidirectional Replication Fork

Eukaryotes DNA → Made up of Many Replicon

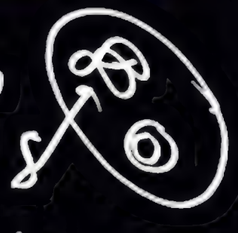
- origin present in Centre of Replicon

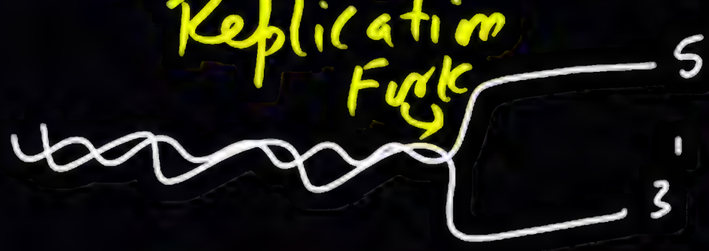


origin → DNA open → DNA Replication Start

Q1 origin is Rich in Base pair
(a) AT (b) GC

- DNA open at origin, DNA Replication occur in Both Direction





- 1 Replicon ⟶ 2 Replication Fork generate

Replication Fork

total DNA = many Replicon → Each Replicon
- one origin (centre)
- two terminus
- two Replication Fork

Q DNA have 10 Replicon then no. of Replication Fork
(a) 5 (b) 20 (c) 10
(d) 30

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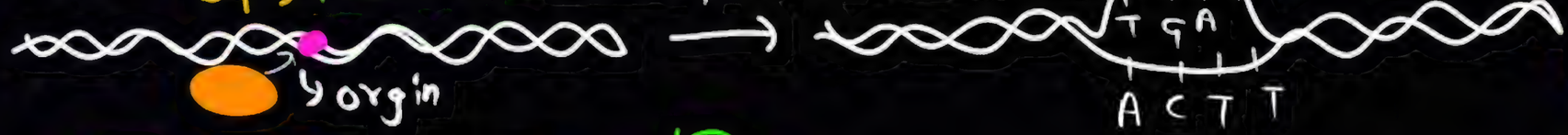
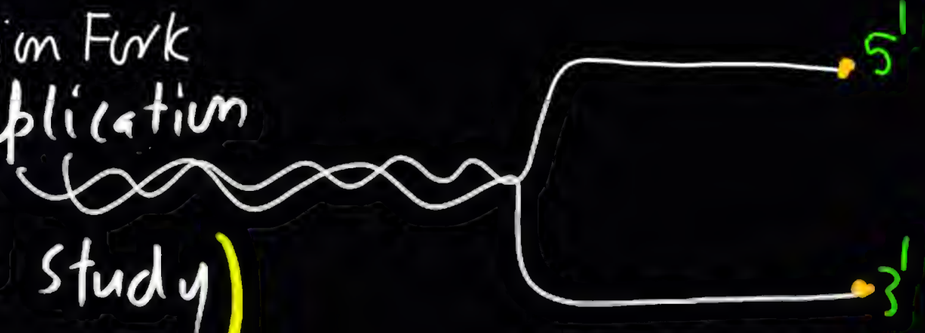
Steps in DNA Replication

1. By → Helicase – DNA open → H-Bond Break → Open DNA Base pair complimentary (DNA can get close Again



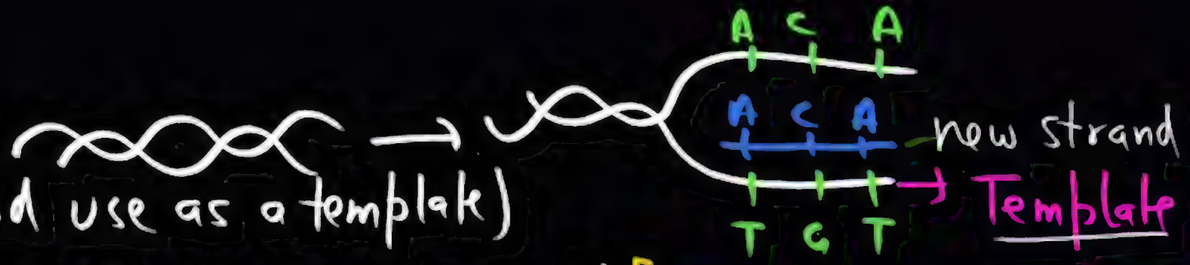
2.

3. Replication Fork (DNA Replication (Process study)



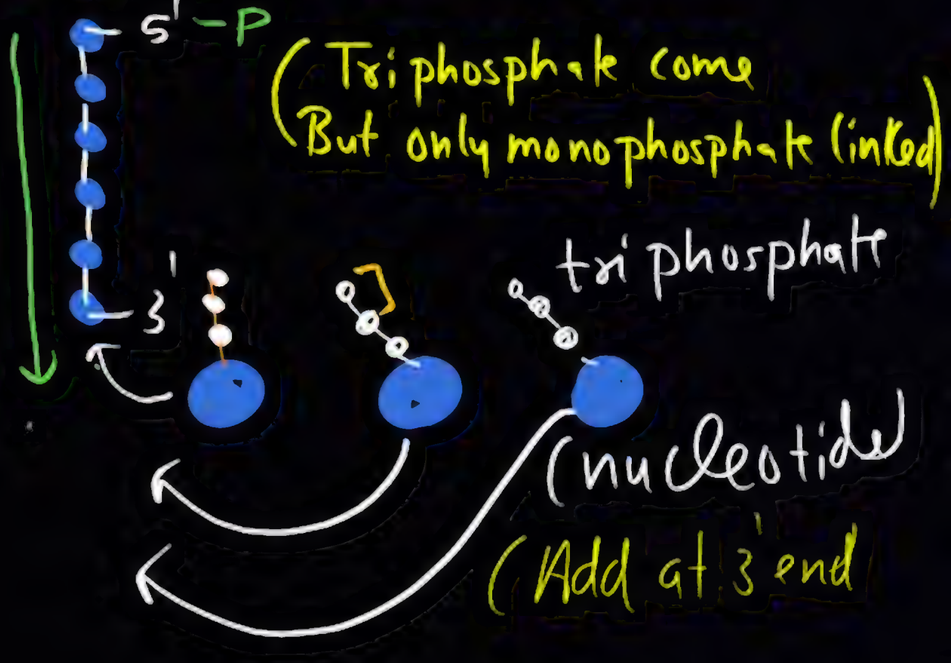
① Helicase → DNA open at origin
② SSB – Single strand Binding protein (Keep DNA single strand)
③ Topoisomerase – When DNA open From centre → -ve supercoiling occur → topoisomerase dec. -ve supercoiling

DNA polymerase

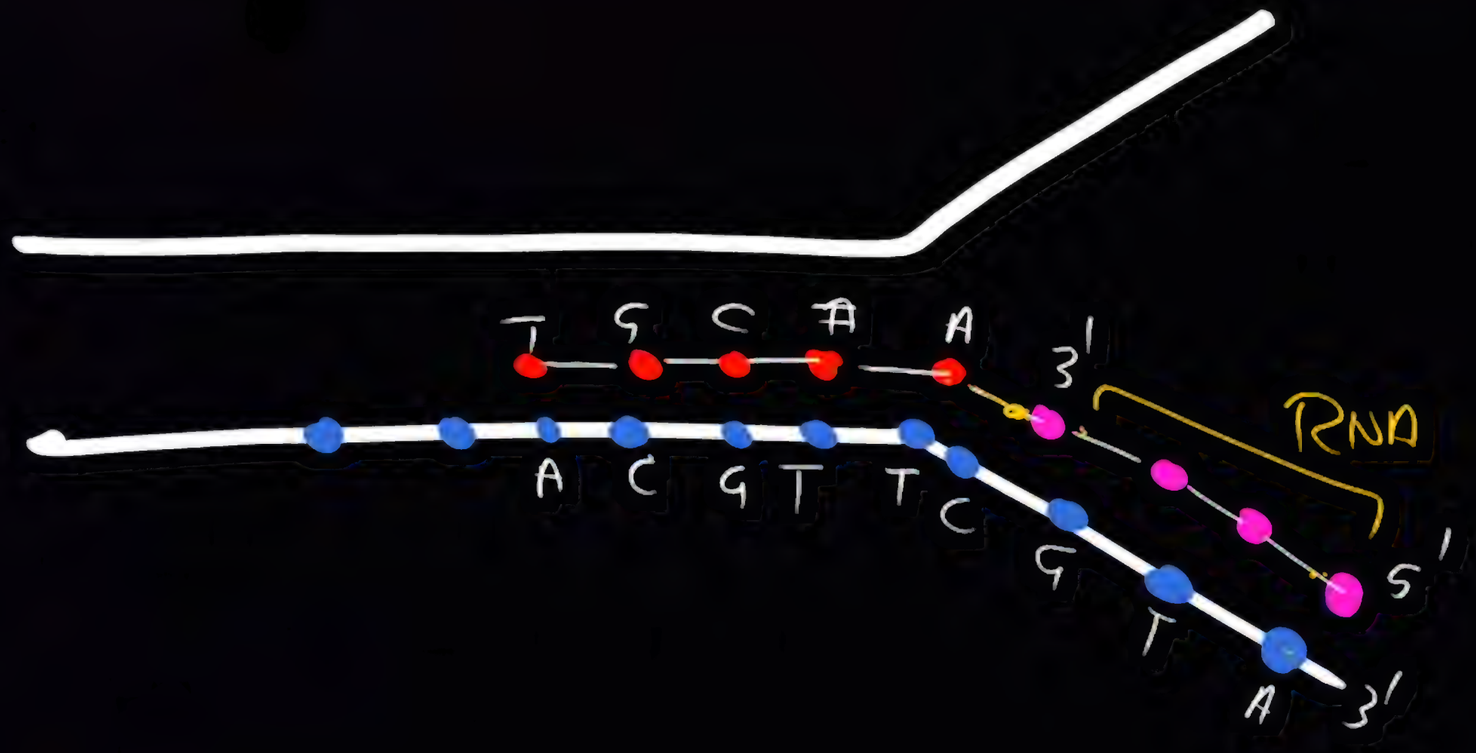


- Use DNA as template (Both strand use as a templak)
- Substrak → dNTP (deoxy ribos nucleoside tri phosphak) [dGTP, dTTP, dCTP, dATP]
  - ↳ Double/Dual Role — ① Act as Substrak ② Provide Energy

- DNA polymerase Two Requirement
  - ① New Nucleotide Add only at 3' end (Chain/new strand Form only in 5'-3' Direction)
  - ② DNA polymerase → Small segment of DNA or RNA (which is primer) (Living system → RNA primer)



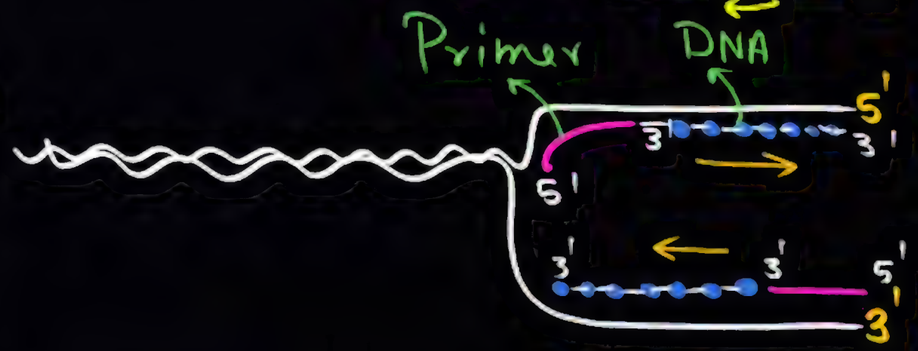
(Tri phosphak come But only monophosphak (linked)


U G C A A
3'
RNA
A C G T T C G T A
5'
3'

4.

* RNA polymerase / Primase → Synthesise primer which is small RNA → on Both strand

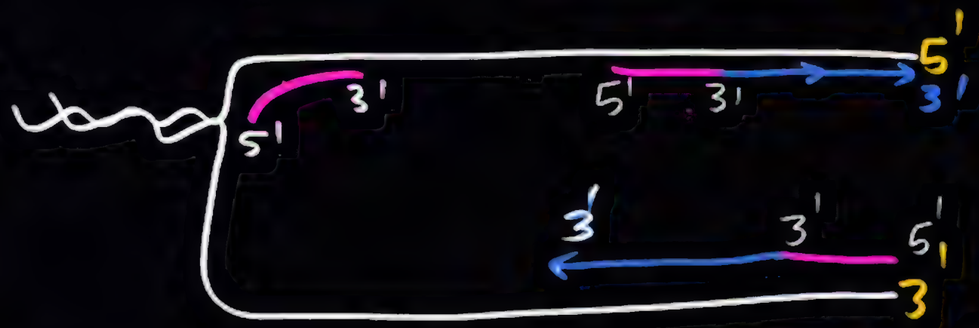
5.



→ Since DNA Replication occur only in 5'-3' Direction on Both strand → DNA Replication occur in Different Direction

→ DNA Replication By DNA polymerase

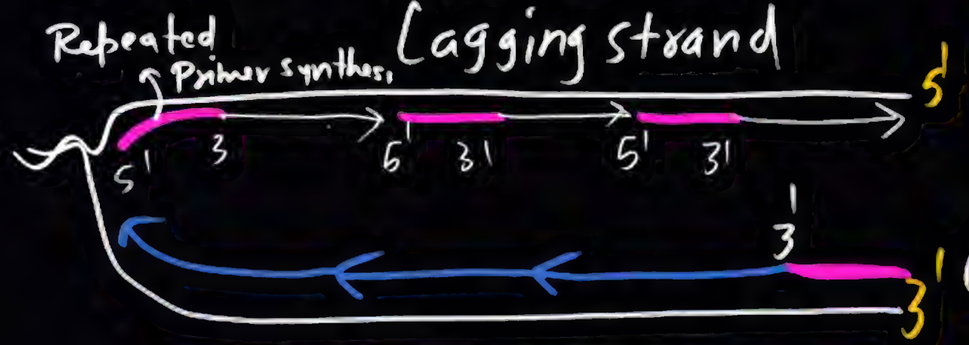
6.



total DNA not open at once, DNA open again at one strand we need to synthesise primer again → Discountinuous DNA synthesis occur

Other strand countinuous DNA Synthesis occur

7.

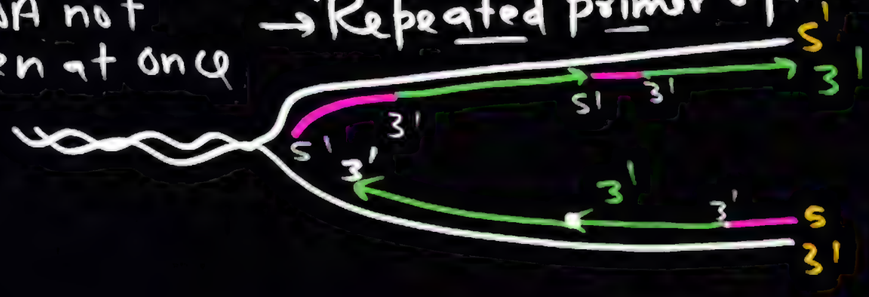


Countinuous DNA synthesis occur → leading strand

(Discountinuous)

All DNA not open at once

→ Repeated primer synthesis – lagging strand



Leading strand – Countinuous DNA Replication

* Direction of DNA Replication

(a) Leading strand – countinuous
Away From origin towards Replication Fork

(b) Lagging strand – Discountinuous
Away From Replication Fork towards origin

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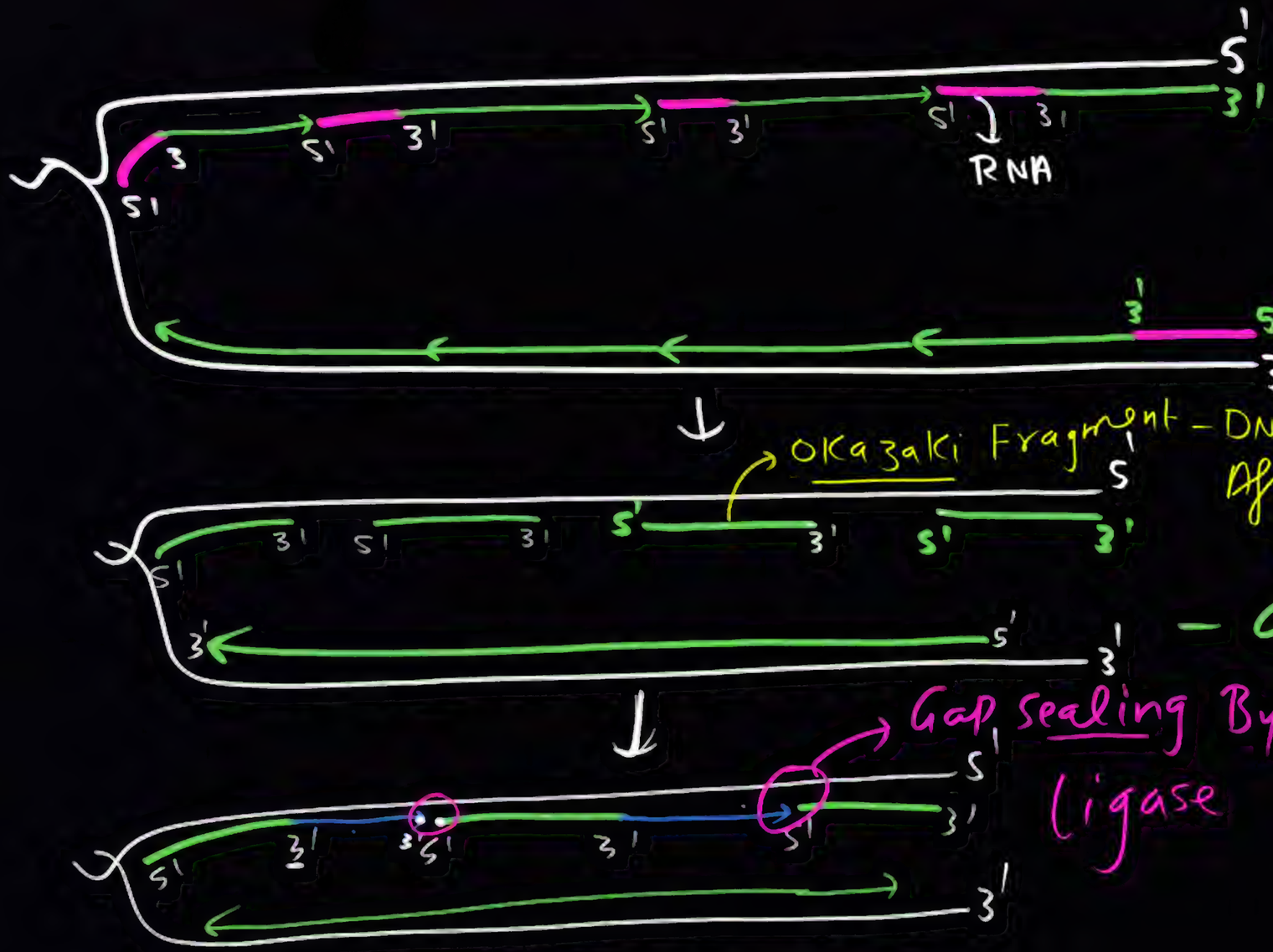


RNA Primer Remove

Okazaki Fragment - DNA segment After Removal of Primer - Form on lagging strand

- Gap is Filled By DNA Polymerase

Gap sealing By ligase

Enzyme:-

① Helicase – DNA open

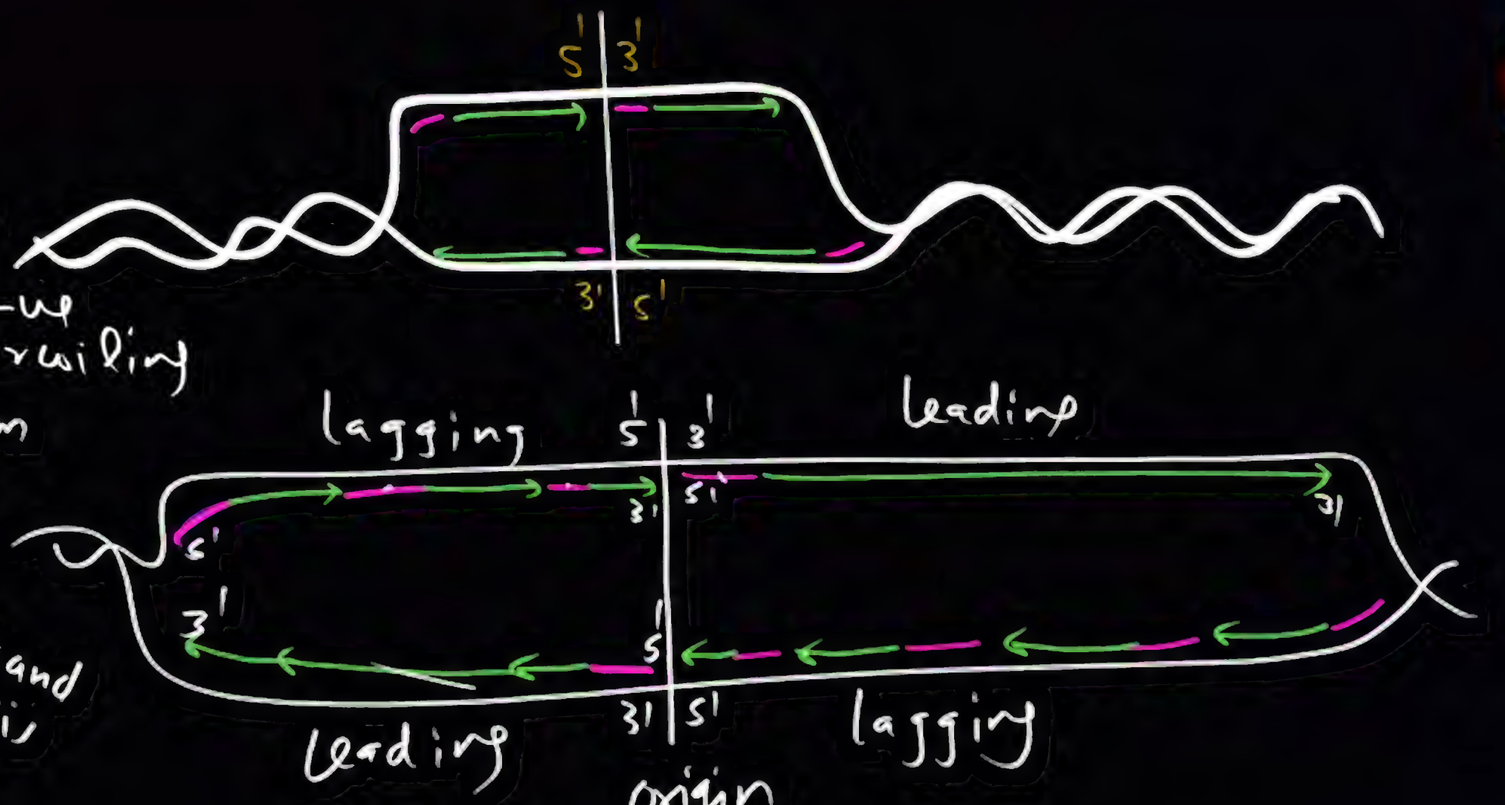
② SSB – Keep DNA open

③ Topoisomerase – dec -ve supercoiling

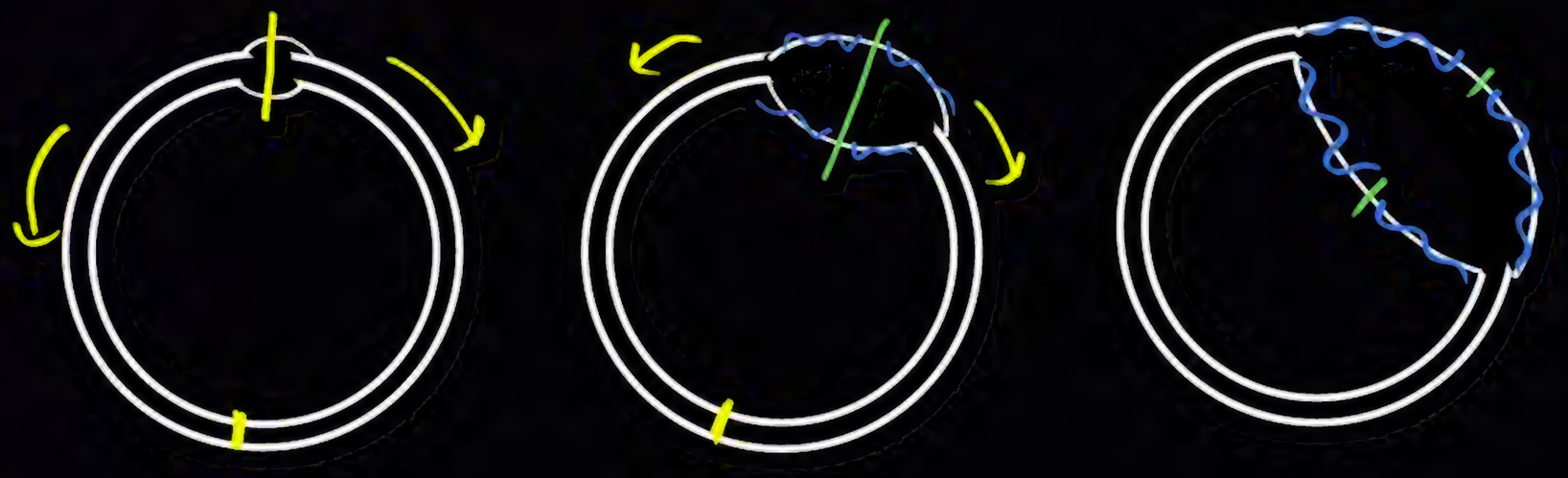
④ Primase – Primer From

⑤ DNA polymerase → New strand synthesis

⑥ Ligase → Seal two DNA strand



SANKALP NEET VEDANTU



DOPA

Q1 DNA Replication occur in E.coli

(a) S phase (b) Cytoplasm (c) After Fission (d) all

Q2 Substrate For DNA Polymerase

(a) dATP (b) dGTP (c) d TTP (d) all

Q3 Direction of DNA Replication is

(a) 5'–3' (b) 3' to 5' (c) Same to primer synthesis (d) Both a & c

Q4 Origin is Located on

(a) Plasmid (b) DNA in Eukaryotes (c) Nucleoid (d) all

Q5 Eukaryotes & Prokaryotes have similarity

(a) Direction of DNA Replication (b) No. of origin (c) Speed of DNA Replication (d) all

Q6 Primase Enzyme use in DNA Replication – not true

(a) template DNA (b) Direction $5'-3'$ (c) Substrate dNTP (d) RNA primer Form

Q7 DNA is sealed By

(a) Isomerase (b) Ligase (c) Helicase (d) all

Q8 lagging strand not true

(a) Countinuous DNA synthesis (b) Single primer (c) Okazaki Fragment Present (d) Replication towards origin

MANTHAN NEET 2025 1.0 to 2.0

SANKALP NEET VEDANTU

Molecular Basis of inheritance

lecture - 07

Botany

TARUN SIR

Topic

structure of nucleic Acid ✓ (Biomolecule) Question - 7

Discovery of DNA →

Watson and crick model →

Packaging of DNA →

Search of Genetic material → (Experiments)

DNA Replication (Experiment, Process)

Transcription – Process

Type of RNA →

Genetic code →

Translation →

Gene Expression →

Human Genome project →

DNA fingerprinting →

cell theory

DNA Replication

Prokaryotes

① location - Cytoplasm

② Prior to Fission

③ Single origin → ori
(Single Replicon)

④ Speed Faster than Eukaryotes
2000 bp/sec

DNA Replication

Eukaryotes

① location – nucleus

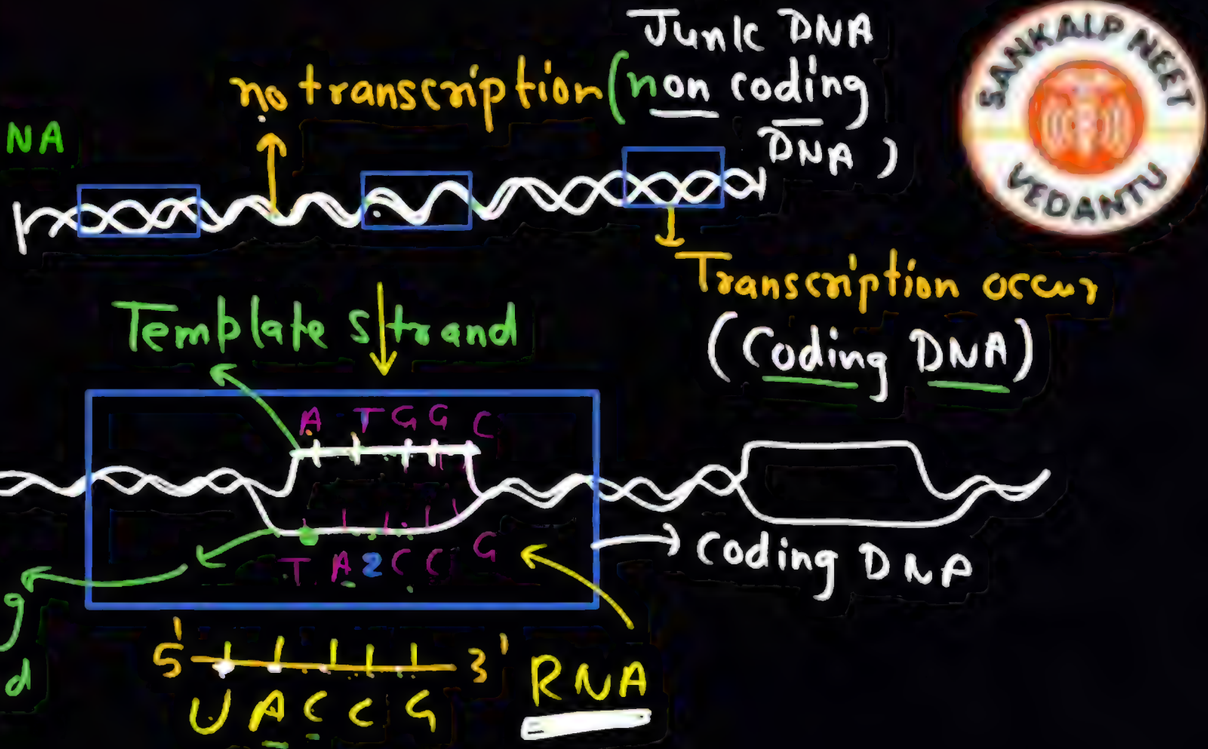
② S-phase

③ Many Replicon, Many origin

④ Speed slower than Prokaryotes

Transcription

definition – Copying information of DNA in Form of RNA



Important point

(a) total DNA not undergo transcription
(DNA have some coding & some non coding part

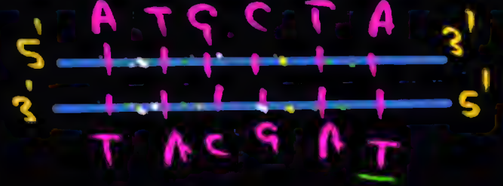
(b) Only one strand show transcription
(One strand Act as template)

(c) During RNA synthesis, in place of T in RNA U present.

(d) Transcription occur in mainly in G_1 & G_2 phase

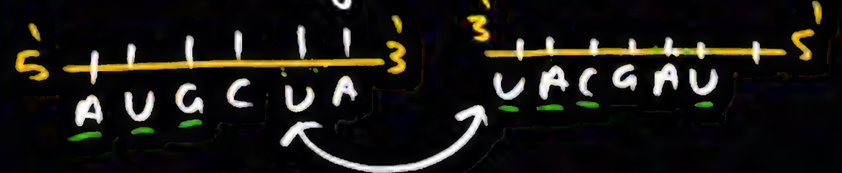
(e) In transcription also → New strand of RNA Form By Complimentary Base pairing

Why Both Strand of DNA not show transcription



Case-I- Both strand Show Transcription same time

→ Both RNA Form together



Complimentary RNA

(ds RNA Form → no translation occur)

Case-II → Both strand Show transcription different time

↓

(Two Different RNA Form)

↓ Protein

↓ Protein

Two different type protein Form

(Gene Expression machinery complicate)

5.5 TRANSCRIPTION

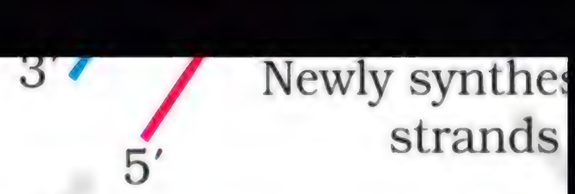


Figure 5.8 Replic

The process of copying genetic information from one strand of the DNA into RNA is termed as **transcription**. Here also, the principle of complementarity governs the process of transcription except the adenosine complements now forms base pair with uracil instead of thymine. However, unlike in the process of replication, which once set in, the total DNA of an organism gets duplicated, in transcription only a segment of DNA and only one of the strands is copied into RNA. This necessitates defining the boundaries that would demarcate the region and the strand of DNA that would be transcribed.

Why both the strands are not copied during transcription has the simple answer. First, if both strands act as a template, they would code for RNA molecule with different sequences (Remember complementarity does not mean identical), and in turn, if they code for proteins, the sequence of amino acids in the proteins would be different. Hence, one segment of the DNA would be coding for two different proteins, and this would complicate the genetic information transfer machinery. Second, the two RNA molecules if produced simultaneously would be complementary to each other, hence would form a double stranded RNA. This would prevent RNA from being translated into protein and the exercise of transcription would become a futile one. waste

Transcription unit

→ Transcription occur in small independent units

→ Such unit is known as transcription unit

→ Transcription unit → three component

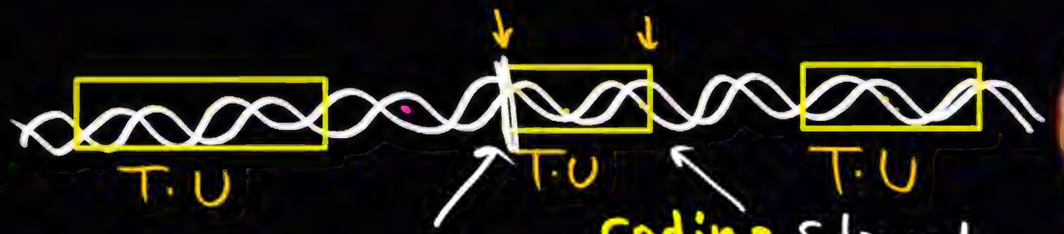
(a) Promoter → help to start transcription

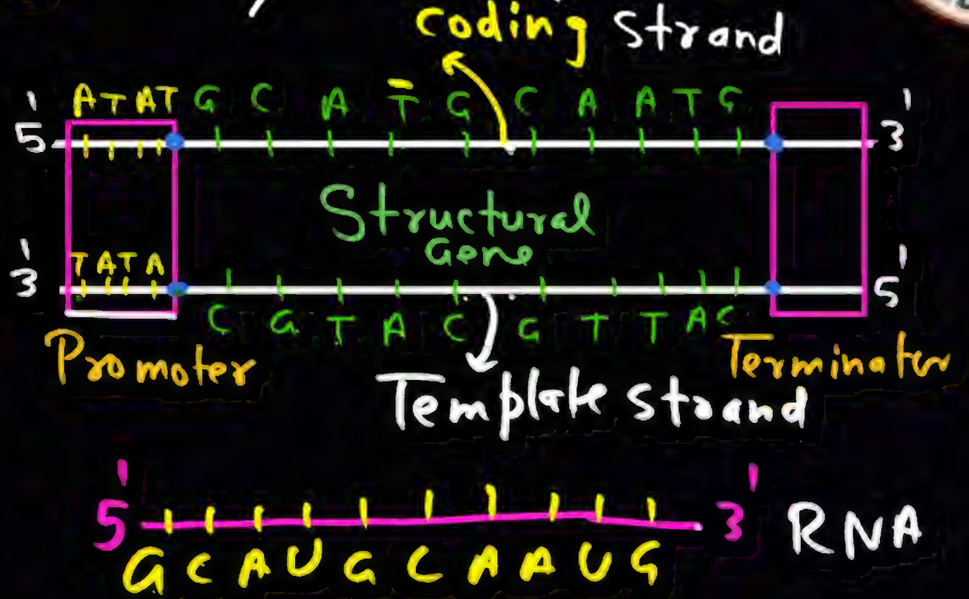
(b) Terminator – help to stop transcription

(c) Structural Gene (Double strand DNA Actual transcription occur)

(i) Coding strand → Similar to RNA (T in place of U)

(ii) template strand → Complimentary to RNA



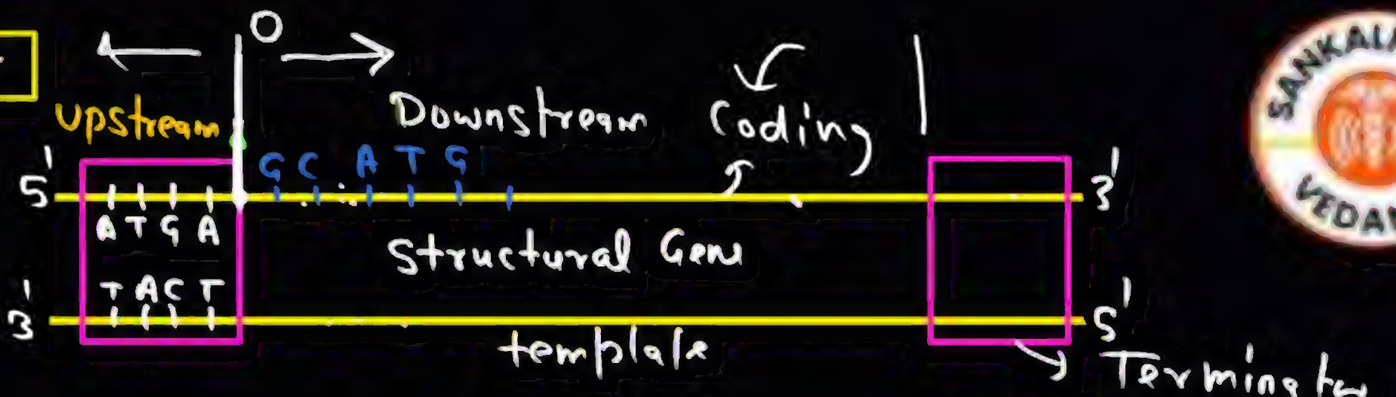


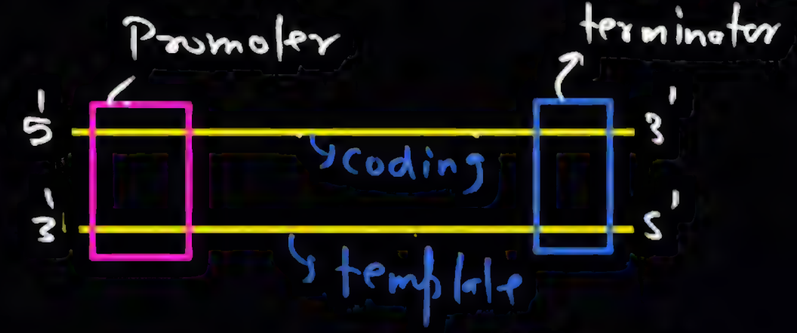
location of Promoter and terminator

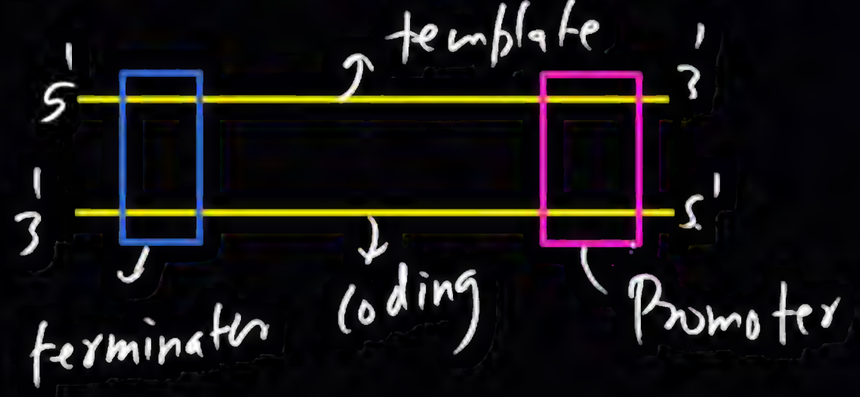
* Promoter is located ⟶ At 5' end upstream of Coding Strand

* Terminator is located at 3'-end down stream of coding strand

* Position change For promoter & terminator ⟶ Coding & template get change







Q If sequence of mRNA is 5' AUGCAUG 3'

Coding strand sequence → 5' ATGCATG 3' → coding strand

template → 3' TACGTAC 5' → template

Q If Sequence of template → 5' ATGCAGT 3'

mRNA → ?

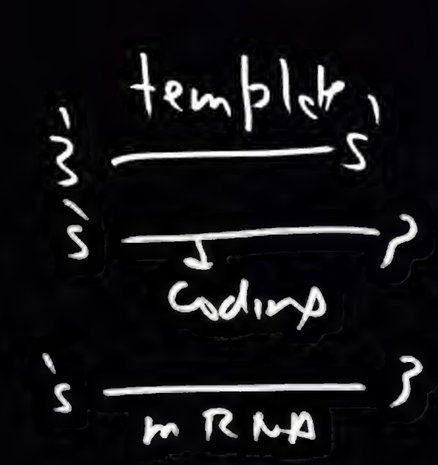
If Sequence → mRNA → 5' AUGCAU 3']

template (5'—3')

5' ATGCAT 3'

3' TACGTA 5' Template]

5' ATGCAT 3' Coding]



or 3' TGACGTA 5' Template

5' ACTGCAT 3' Coding

5' ACUGCAU 3' ✓

DNA Replication

→ S- phase

→ Entire DNA Replicate

→ Both strand Act as template

→ Enzyme – DNA Dependent DNA polymerase

→ Substrate → dNTP (dATP, dGTP, dTTP, dCTP)

Transcription

→ G_1 & G_2 phase

→ Small segments → coding DNA / transcriptionally Active

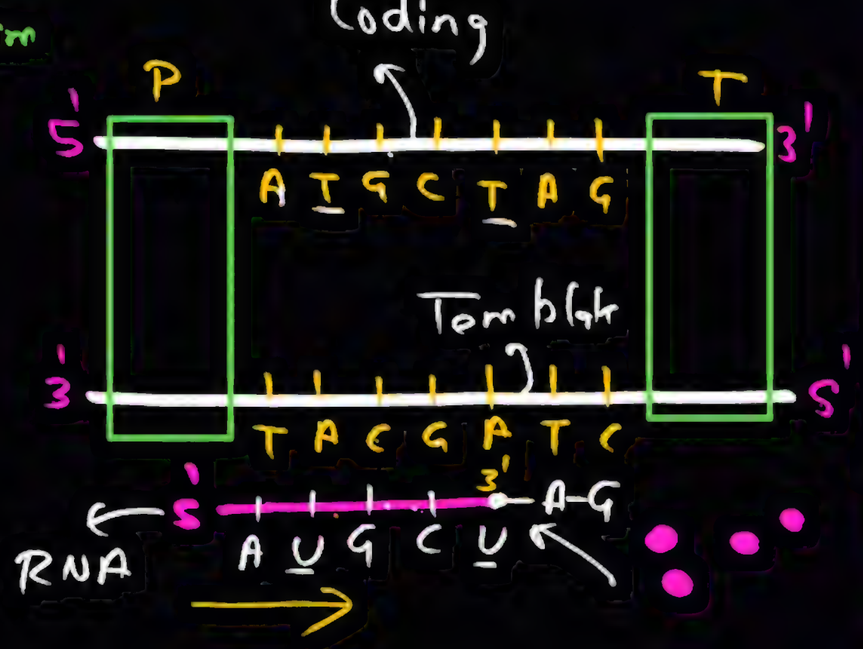
→ only one strand Act as template

→ Enzyme – DNA Dependent RNA polymerase

Substrate → ATP, GTP, UTP, CTP

Transcription steps

- location → Eukaryotes → nucleus, Mitochondria & chloroplasm
  → Prokaryotes → Cytoplasm
- Enzyme → RNA polymerase (DNA dependent RNA polymerase)
- Direction → New RNA Form 5'—3'
  (new nucleotide Add at 3' end)
- Principle → Complimentary Base pairing
- RNA polymerase open DNA itself (No Helicase) and only one strand transcription (single Direction)
  no primer Require
  (No okazaki Form in transcription)



Transcription
DNA open by
(a) Helicase (b) DNA Poly
(c) RNA Poly

DOPA

Q1 DNA Replication occur in E.coli

(a) S phase (b) Cytoplasm (c) After Fission (d) all

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Q3 Direction of DNA Replication is

(a) 5'–3' (b) 3' to 5' (c) Same to primer synthesis (d) Both a & c

5–3'

Q4 Orgin is Located on

(a) Plasmid (b) DNA in Eukaryotes (c) Nucleoid (d) all

Q5 Eukaryotes & Prokaryotes have similarity

(a) Direction of DNA Replication (b) No. of orgin (c) Speed of DNA Replication (d) all

Primer - RNA

Q6 Primase Enzyme use in DNA Replication – not true

(a) template DNA (b) Direction 5'–3' (c) Substrate dNTP (d) RNA primer Form

dNTP → deoxy

Q7 DNA is sealed By

(a) Isomerase (b) Ligase (c) Helicase (d) all

Q8 lagging strand not true

(a) Countinuous DNA synthesis (b) Many primer (c) Okazaki Fragment Present (d) Replication towards origin

MANTHAN NEET 2025 1.0 to 2.0

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Molecular Basis of inheritance

Lecture - 08

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TARUN SIR

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Search of Genetic material → (Experiments)

DNA Replication (Experiment, Process)

Transcription – Process

Type of RNA →

Genetic code →

Translation →

Gene Expression →

Human Genome project →

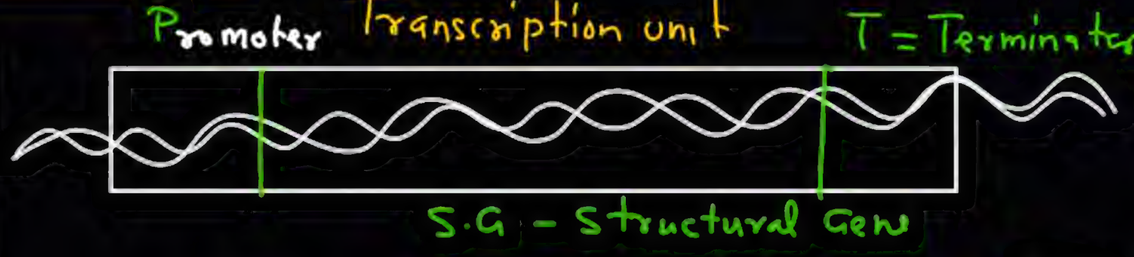
DNA fingerprinting →

cell theory

Steps in transcription

Enzyme

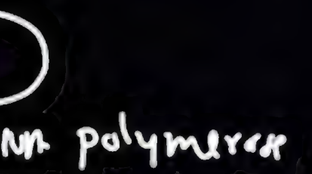
RNA polymerase
(DNA Dependent RNA Polymerase)



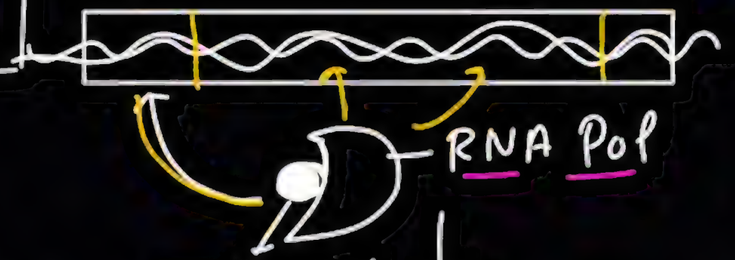
– Transcription – RNA Form (which a polymer of nucleotide)

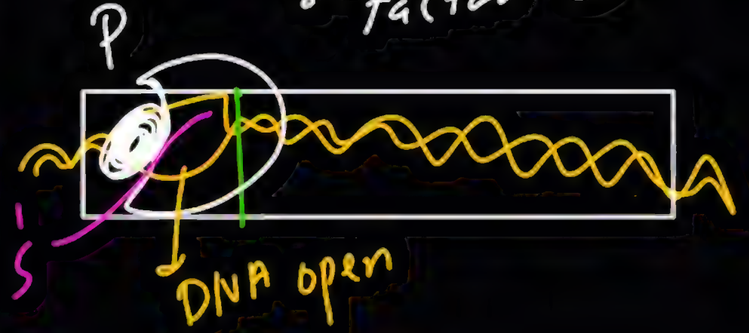
Three step → ① Initiation
② Elongation
③ Termination

I **Initiation**



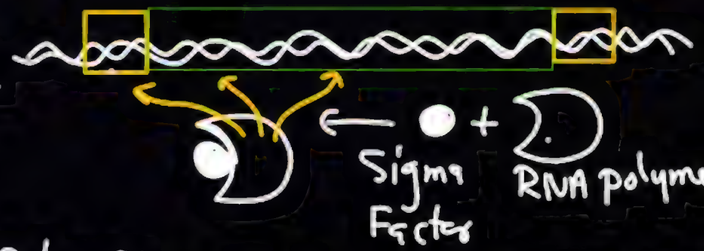
Protein → Sigma factor – help to identify promoter

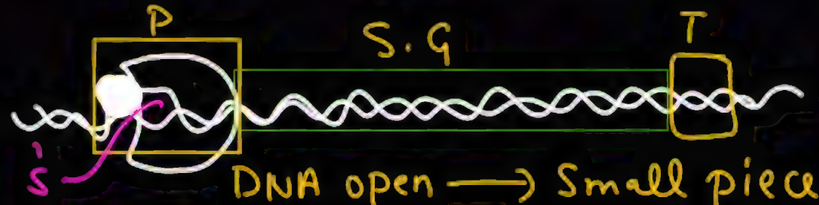




- RNA polymerase & Sigma Factor Recognise Promoter
- When Bind on promoter (DNA open → small piece of RNA form)

(A) Initiation

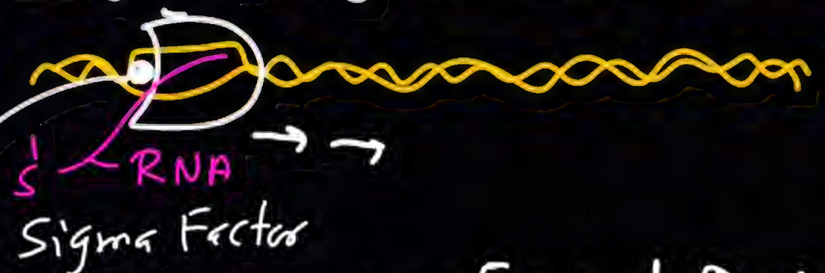


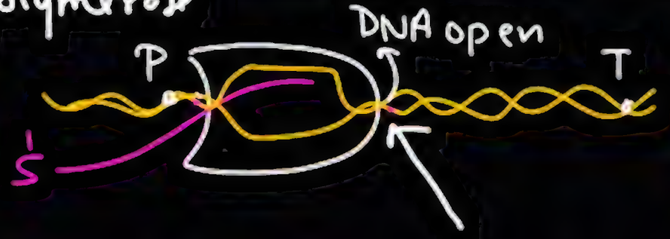


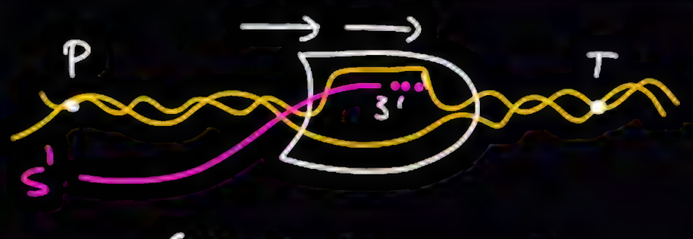
DNA open ⟶ Small piece of RNA Form (Sucessful initiation)

• RNA Pol + Sigma Factor ⟶ Bind on promoter ⟶ DNA open ⟶ Small piece of RNA ⟶ Sucessful initiation

(B) Elongation ⟶ Sigma Factor leave RNA polymerase







→ RNA polymerase move Forward, DNA unwind (one side) & Close other side (DNA open only place where RNA polymerase Bind

(C) Termination ⟶ RNA polymerase Reach up to terminator Region

• Rho factor help in termination

• At terminator ⟶ Rho factor Remove RNA ↓ RNA polymerase Close DNA ⟶ RNA polymerase Removed

Initiation	– at promoter	– RNA Pol + Sigma Factor (Promoter Recognition)
Elongation	– Structural Gene	– RNA polymerase ✓
Termination	– Terminator Region	→ RNA polymerase + Rho factor

note – Sigma Factor help in promoter Recognition

Direction of transcription → 5'——3'

Similarity B/w DNA Replication & Transcription

(a) Direction → 5'—3' (new nucleotide at 3' end)

(b) template is DNA

(c) Principle → Complimentary Base pairing

(d) location same in Eukaryotes – Nucleus

DNA Replication

→ Occur For Comptete DNA

→ S-phase

→ Enzyme – DNA Polymerase

→ Primer Require

→ Both strand of DNA template

→ Helicase open DNA

Transcription

– Only Some part

→ G_1 & G_2

– RNA polymerase

– No primer Require

→ only one strand of DNA is template

– No Helicase Require

Type of RNA

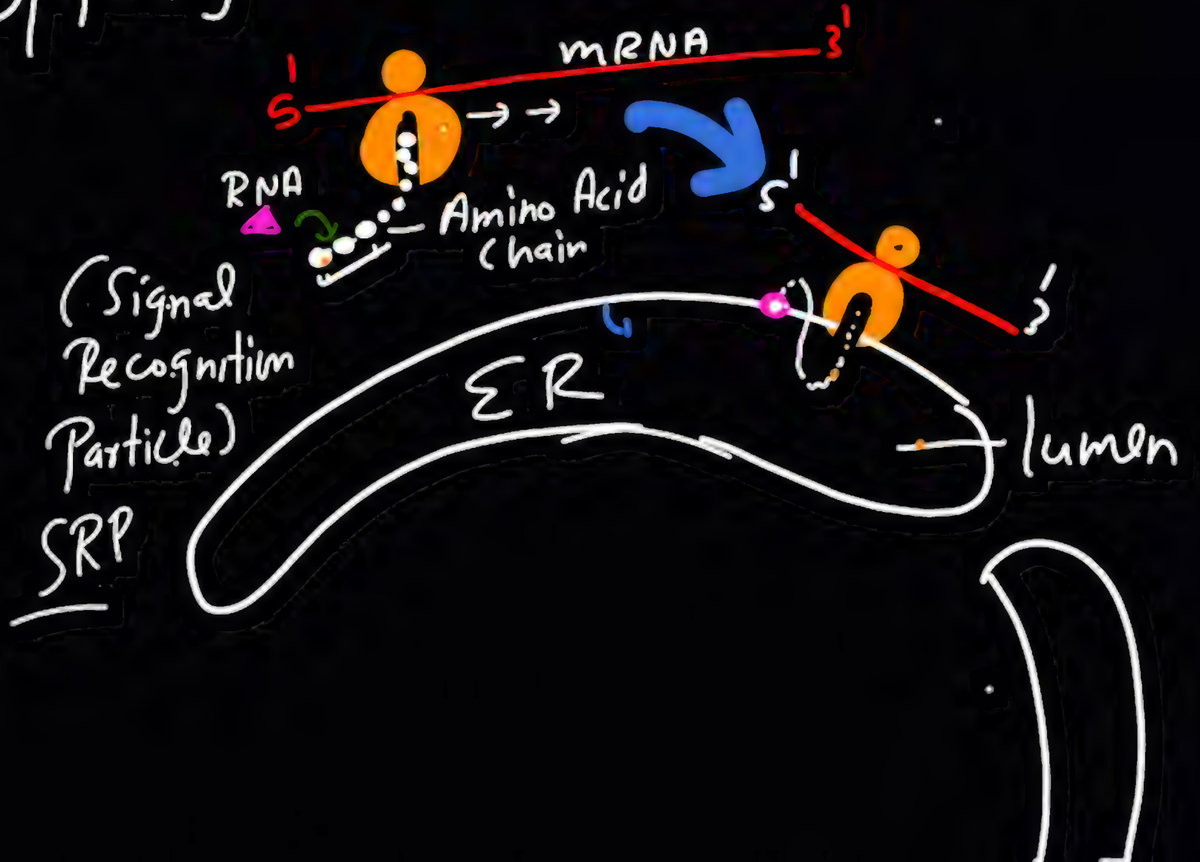
(a) ribosomal RNA | rRNA ⟶ Catalytic Role and structural Role

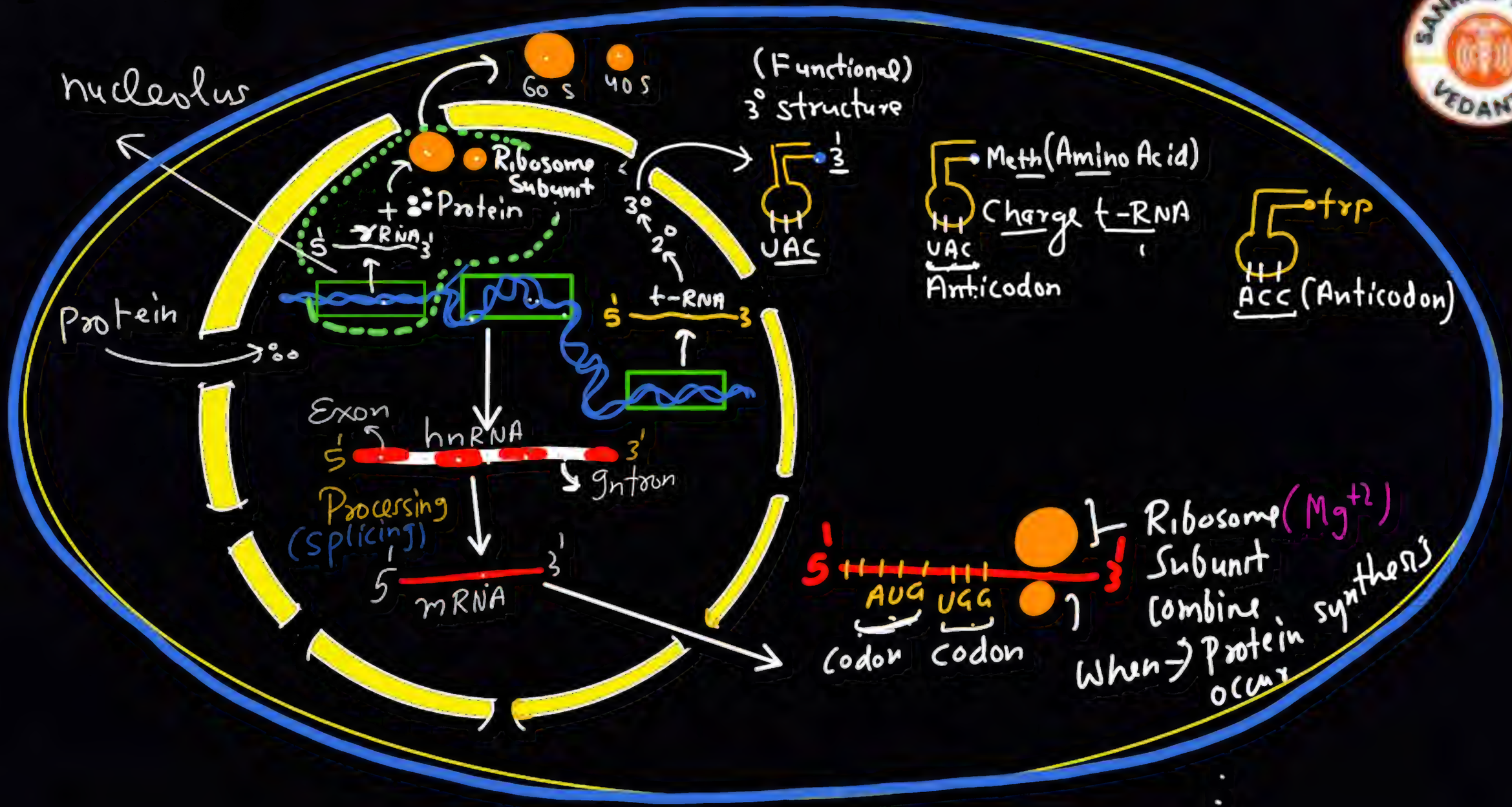
(b) messenger RNA ⟶ Information Copy of DNA For polypeptide

(c) transfer RNA | Soluble RNA | Adapter molecule ⟶ It Read code on mRNA ✓
it bring Amino Acid at the site of protein synthesis ✓

(d) Sn RNA – Small nuclear RNA
(help in processing of hnRNA) | Splicing

(e) Sc RNA – Small cytoplasmic RNA
(Bring cytoplasmic Ribosome
on Surface of ER




nucleolus
60 S
40 S
Ribosome Subunit
+ Protein
5' rRNA 3'
Protein
Exon
5' hnRNA 3'
Intron
Processing (splicing)
5' mRNA 3'
(Functional) 3° structure
5' 3'
UAC
3° 2°
5' t-RNA 3'
Meth (Amino Acid)
Charge t-RNA
UAC
Anticodon
trp
ACC (Anticodon)
5' 3'
AUG UGG
Codon Codon
Ribosome (Mg^{+2}) Subunit combine
When → Protein synthesis occurs

Important points

(a) Ribosome subunit Form inside - nucleus (nucleolus)

(b) Ribosome Assembly ⟶ Cytoplasm (During Protein synthesis)

(c) hnRNA Form inside → nucleus (never come outside nucleus)

(d) Post transcriptional modification → occur in → nucleus (Ex - hnRNA to mRNA)

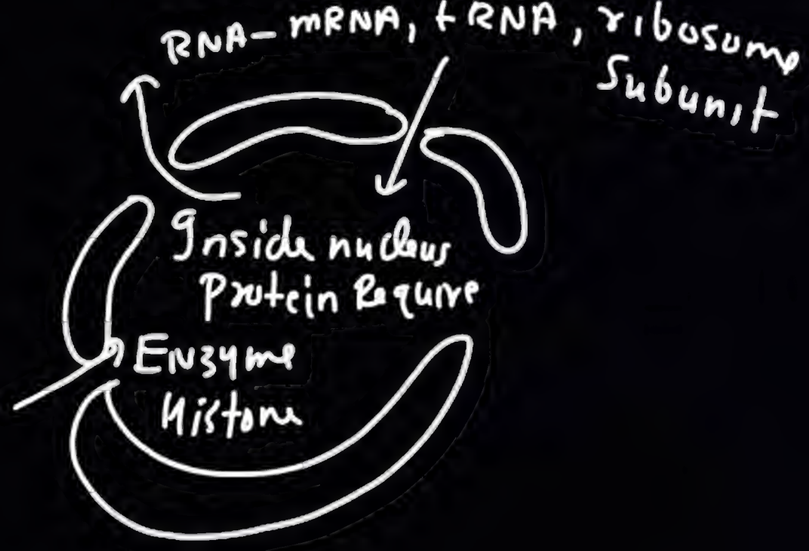
(e) Prokaryotes post transcriptional modification not occur

(f) Prokaryotes → all RNA (t-RNA, mRNA, rRNA Form in cytoplasm

(g) Eukaryotes ⟶ t-RNA & hnRNA → Form in nucleoplasm
rRNA Form in nucleolus

(h) nucleus to cytoplasm Move ribosome subunit, mRNA, t-RNA

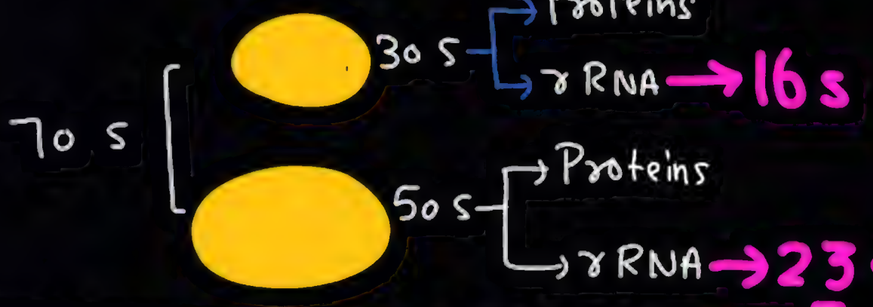
(g) Cytoplasm to nucleus move - Protein For Ribosome

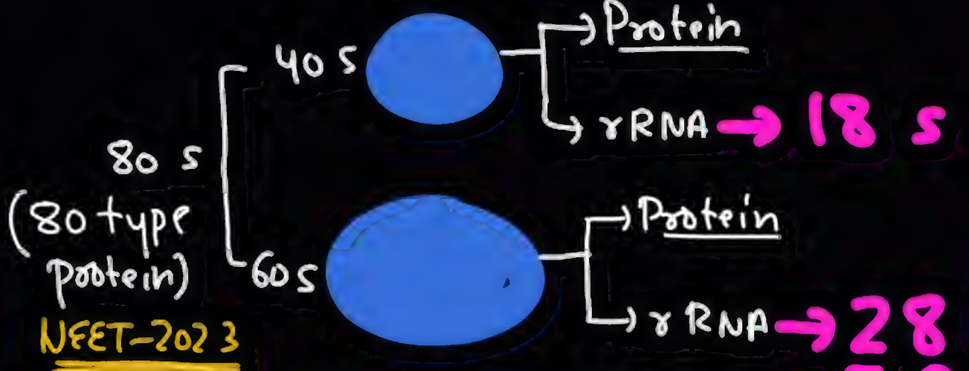


Ribosomal RNA (Part of Ribosome) → most Stable RNA, most Abundant

- Part of Ribosome Subunit
→ 70 s → Prokaryotes Cytoplasm
organelles (Mitochondria, chloroplast)

80 s Ribosome → Eukaryotes Cytoplasm





Prokaryotes

(a) mRNA
(b) tRNA
(c) 16 s, 23 s, 5 s

One type RNA Polymerase all type of RNA Form

Eukaryotes – Three type of RNA Polymerase

RNA Pol I → γ – rRNA (18 s, 28 s, 5.8 s)
RNA Pol II → h – hnRNA
RNA Pol III → t → tRNA, 5 s RNA, Sc RNA
Sr RNA

I	γ
II	h
III	t

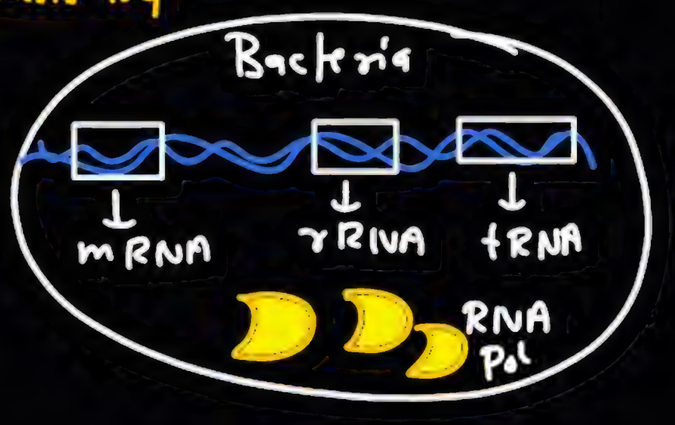
Q 5 s rRNA in E.coli synthesis By

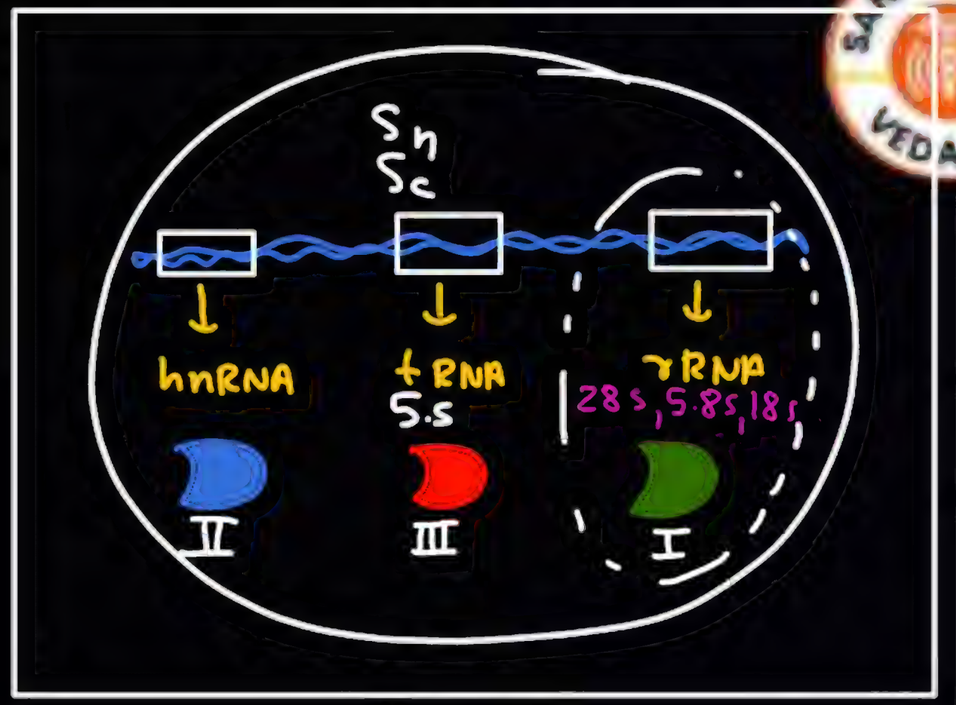
(a) RNA Pol I

(b) RNA Pol III

(c) RNA Pol

(d) RNA Pol II





I – r

II – h

III – t

DOPA

Q1 Not true About DNA polymerase
(a) Both strand template (b) open DNA at orgin (c) Direction 5'–3' (d) location is Cytoplasm in prokaryotes

Q2 RNA polymerase in E. coli synthesis
(a) 5 s rRNA (b) mRNA (c) t-RNA (d) all

Q3 Promoter is Recognise By
(a) Sigma Factor (b) RNA polymerase (c) Sigma + RNA poly (d) none

Q4 Functional structure of t-RNA
(a) 1° (b) 2° (c) 3° (d) all

Q5 Anticodon Region is located on
(a) mRNA (b) t-RNA (c) rRNA (d) all

Q6 Charge t-RNA is
(a) nucleic Acid (b) nucleic Acid & Amino Acid at 5'end (c) Nucleic Acid and Amino Acid at 3'end (d) all

Q7 28 s rRNA is transcribe By
(a) RNA pol I (b) RNA pol II (c) RNA Pol III (d) RNA Polymerase

Q8 5_n RNA is located in
(a) E. coli (b) Yeast nucleus (c) Yeast cytoplasm (d) all

Q9 Which is present only in nucleus not cytoplasm
(a) mRNA (b) hnRNA (c) t-RNA (d) all

Q10 In Mesophyll cell, which is not present in nucleolus
(a) 28 s rRNA (b) 23 s rRNA (c) DNA (d) Ribosome Subunit

Q11 RNA polymerase not transcribe
(a) mRNA (b) t-RNA (c) 23 s rRNA (d) 18 s rRNA

Q12 S-I - From nuclear pore t-RNA move from nucleus to cytoplasm
S-II - t- RNA Read code on mRNA

MANTHAN NEET 2025 1.0 to 2.0

SANKALP NEET VEDANTU

Molecular Basis of inheritance

lecture – ०१

Botany

TARUN SIR

Topic

structure of nucleic Acid ✓ (Biomolecule) Question - 7

Discovery of DNA →

Watson and crick model →

Packaging of DNA →

Search of Genetic material → (Experiments)

DNA Replication (Experiment, Process)

Transcription – Process

Type of RNA →

Genetic code →

Translation →

Gene Expression →

Human Genome project →

DNA fingerprinting →

cell theory

DNA Replication
Prokaryotes

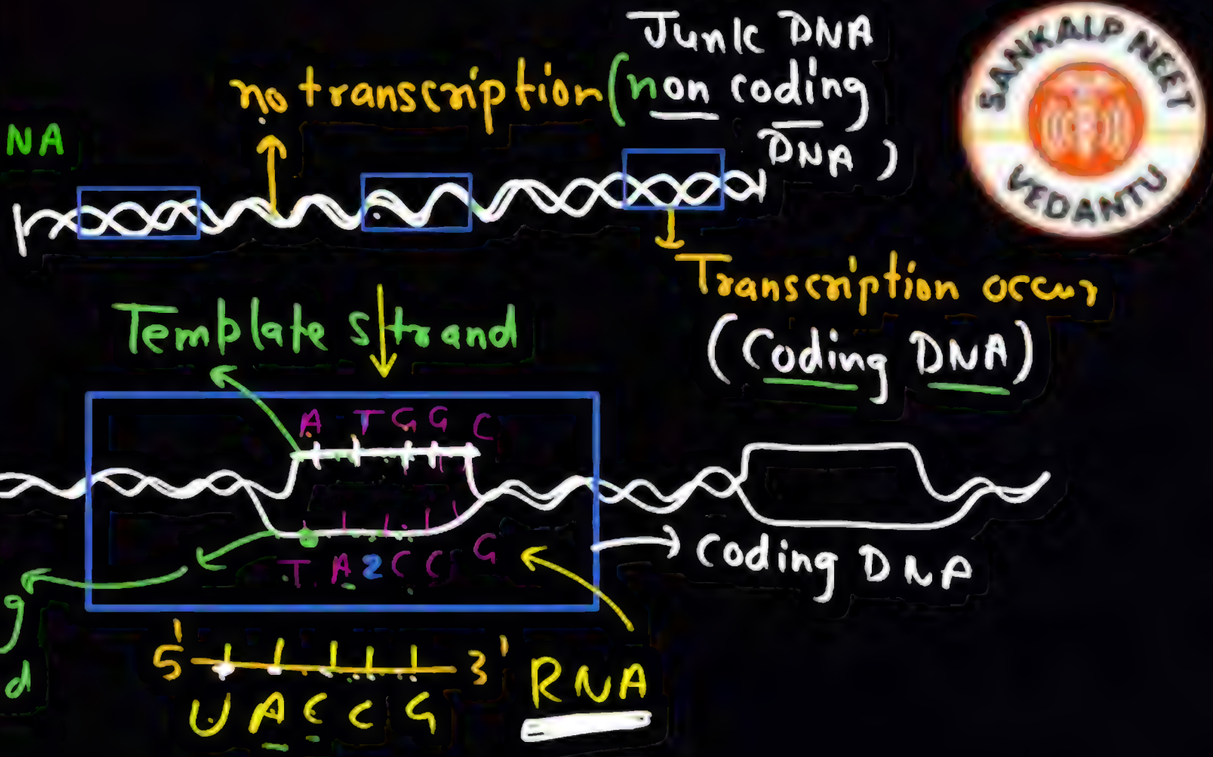
1. location – Cytoplasm
2. Prior to Fission
3. Single origin → ori
   (Single Replicon)
4. Speed Faster than Eukaryotes
   2000 bp/sec

DNA Replication
Eukaryotes

1. location – nucleus
2. S-phase
3. Many Replicon, Many origin
4. Speed slower than Prokaryotes

Transcription

definition – Copying information of DNA in Form of RNA



Important point

(a) total DNA not undergo transcription
(DNA haw some coding & some non coding Part

(b) Only one strand Show transcription
(One strand Act as template)

(c) During RNA synthesis, in place of T in RNA U present.

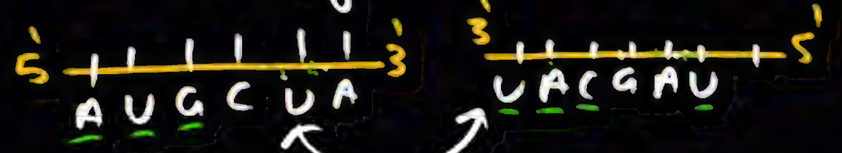
(d) Transcription occur in mainly in G_1 & G_2 phase

(e) 9_n transcription also → New strand of RNA Form By Complimentary Base pairing

Why Both Strand of DNA not show transcription

Case-I- Both strand Show Transcription same time

→ Both RNA Form together



Complimentary RNA

(ds RNA Form → no translation occur)

Case-II → Both Strand Show transcription different time

↓

(Two Different RNA Form)

↓ Protein

↓ Protein

Two different type protein Form

(Gene Expression machinery complicate)

Type of RNA

(a) ribosomal RNA | rRNA ⟶ Catalytic Role and structural Role

(b) messenger RNA ⟶ Information copy of DNA For polypeptide

(c) transfer RNA | Soluble RNA | Adapter molecule ⟶ It Read code on mRNA ✓
it bring Amino Acid at the site of protein synthesis ✓

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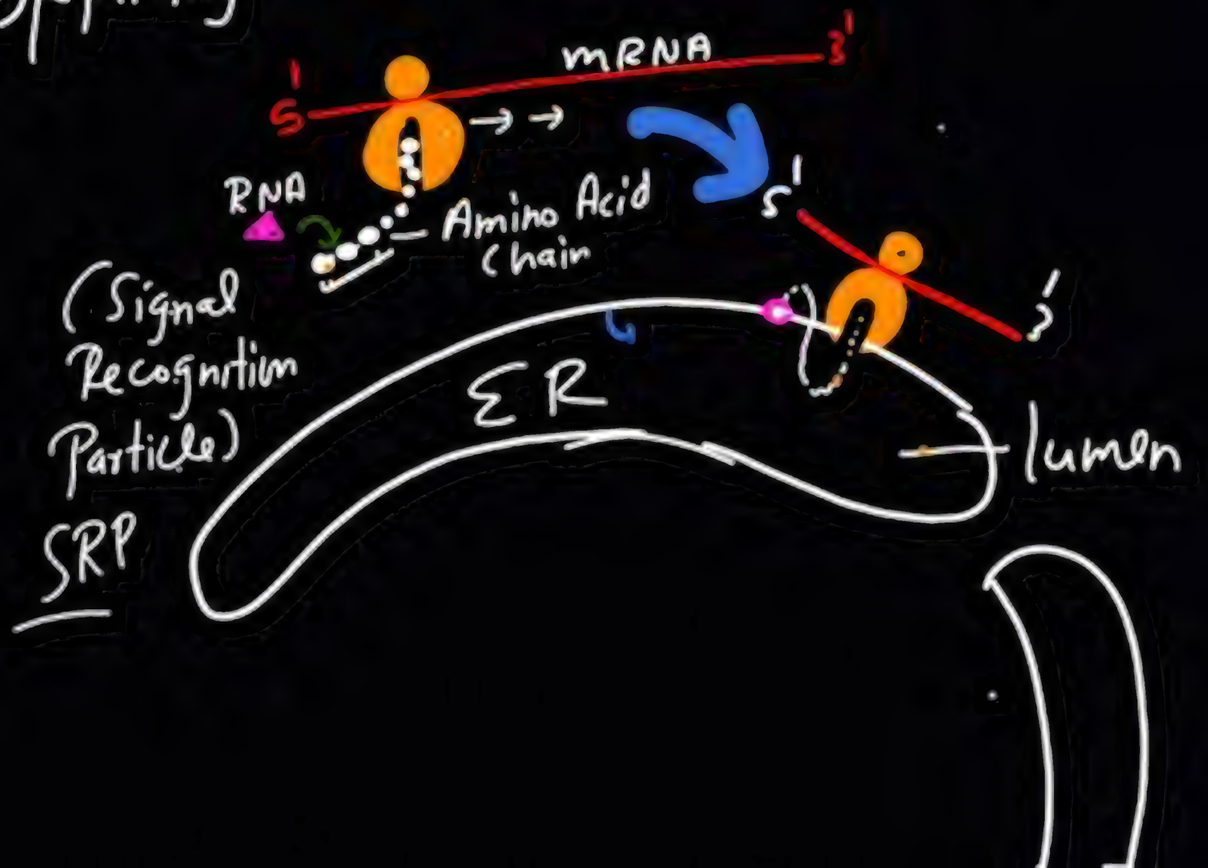

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(a) RNA pol I (b) RNA pol II (c) RNA Pol III (d) RNA Polymerase

Small nuclear

Q8 S_n RNA is located in

(a) E. coli (b) Yeast nucleus (c) Yeast cytoplasm (d) all

Q9 Which is present only in nucleus not cytoplasm

(a) mRNA (b) hnRNA (c) t-RNA (d) all

Q10 In Mesophyll cell, which is not present in nucleolus

(a) 28 s rRNA (b) 23 s rRNA (70 S) (c) DNA (d) Ribosome Subunit

(Prokaryotic)

Q11 RNA polymerase not transcribe

(a) mRNA (b) t-RNA (c) 23 s rRNA (d) 18 s rRNA (Eukaryotic)

Q12 S-I - From nuclear pore t-RNA move from nucleus to cytoplasm ✓

S-II - t-RNA Read code on mRNA ✓

Both Correct

Type of RNA

(a) ribosomal RNA | rRNA ⟶ Catalytic Role and structural Role ✓

(b) messenger RNA ⟶ Information copy of DNA For polypeptide

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it bring Amino Acid at the site of protein synthesis ✓

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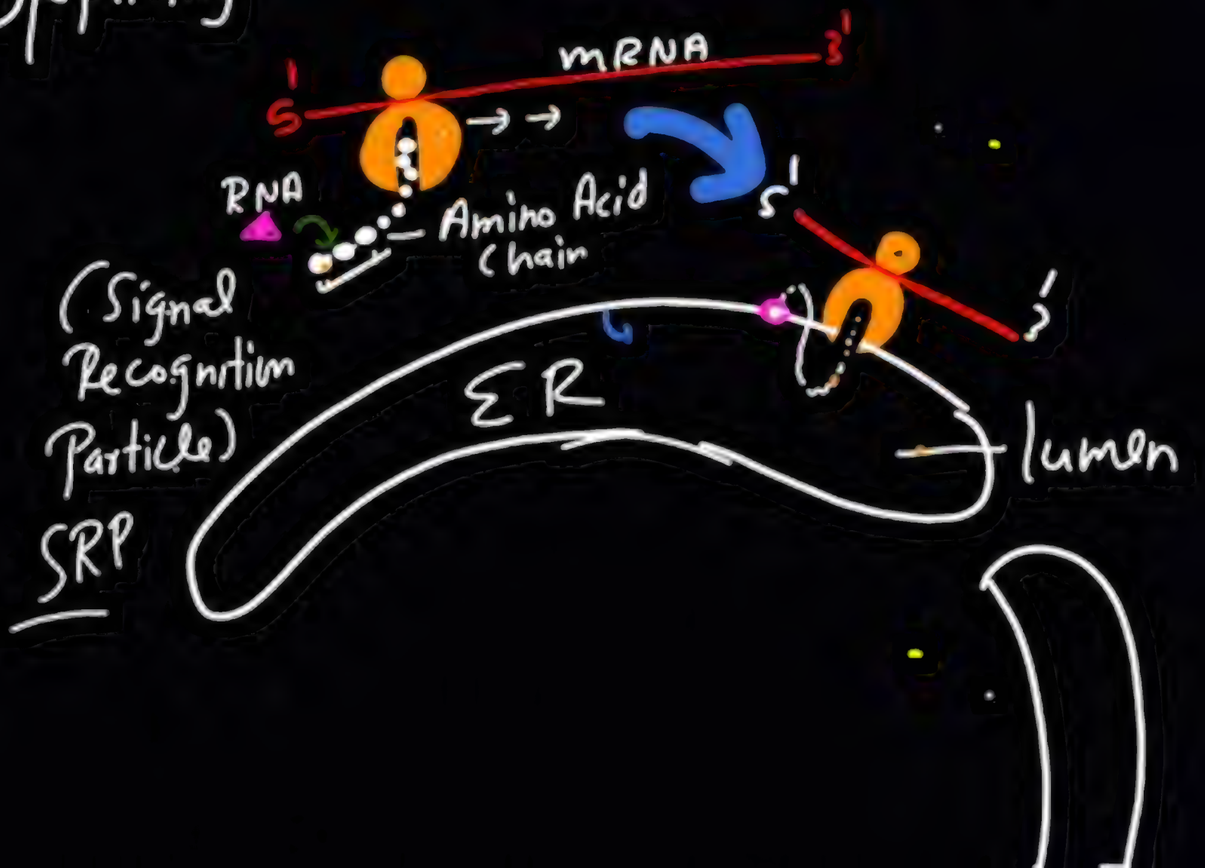


messenger RNA

Prokaryotes → DNA Directly Form mRNA

Eukaryotes → DNA transcribe into hnRNA
(Processing give mRNA)

hnRNA —PTM (Three step)→ mRNA

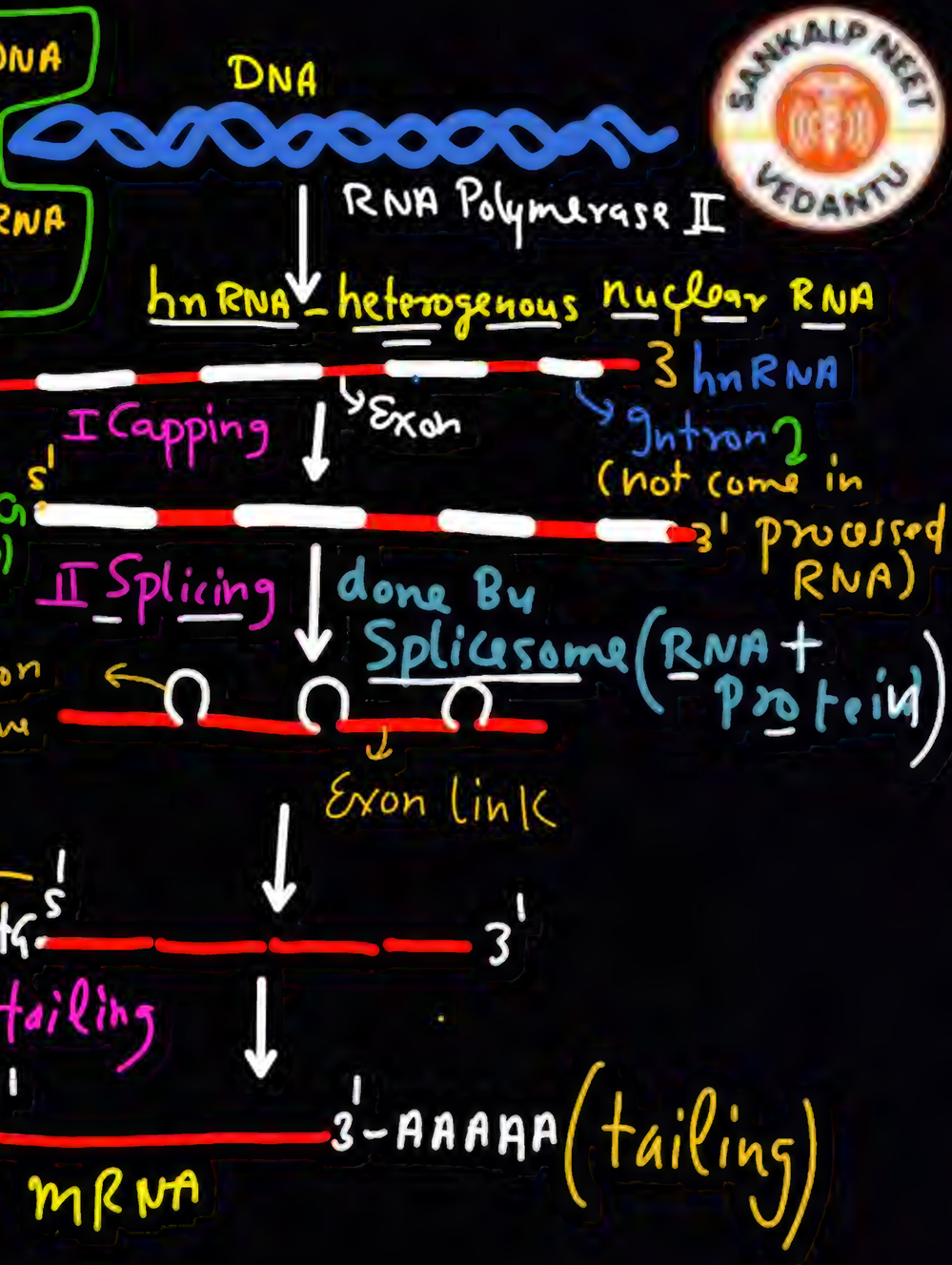
(1) Capping → at 5'end (7-methyl Guanosine tri Phosphate)

(2) Splicing - Introns Remove Exon link

(3) tailing → At 3' end large number of A
(200-300 Polyadenylate Residue link)

PTM
Post transcriptional modification → Capping → 5'end → 7met-G Add
→ Splicing - Remove intron
→ tailing → At 3'end → Poly A tail Add

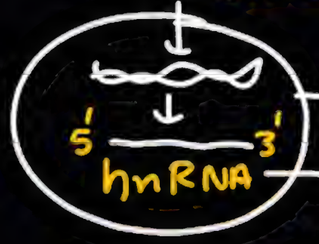
① Non coding part in DNA
(a) Transcription Unit (b) Junk DNA
② Non coding Part in RNA
(a) Exon (b) Intron



Complimentary DNA | C-DNA

Plant (Eukaryotes) → Gene (Eukaryotes)

↓ In Bacteria Give hnRNA (Processing not possible)



E. coli → no Processing

Solution → Eukaryotes gene ↓ mRNA → Reverse transcription → cDNA → Gene (transfer into E. coli) (Processing not Require)

cDNA → It always form mRNA

DNA Eukaryotes

↓ Lab-Reverse transcription

DNA/Gene

cDNA | complimentary DNA (Complimentary to mRNA)

This gene when transfer it form mRNA (not hnRNA)

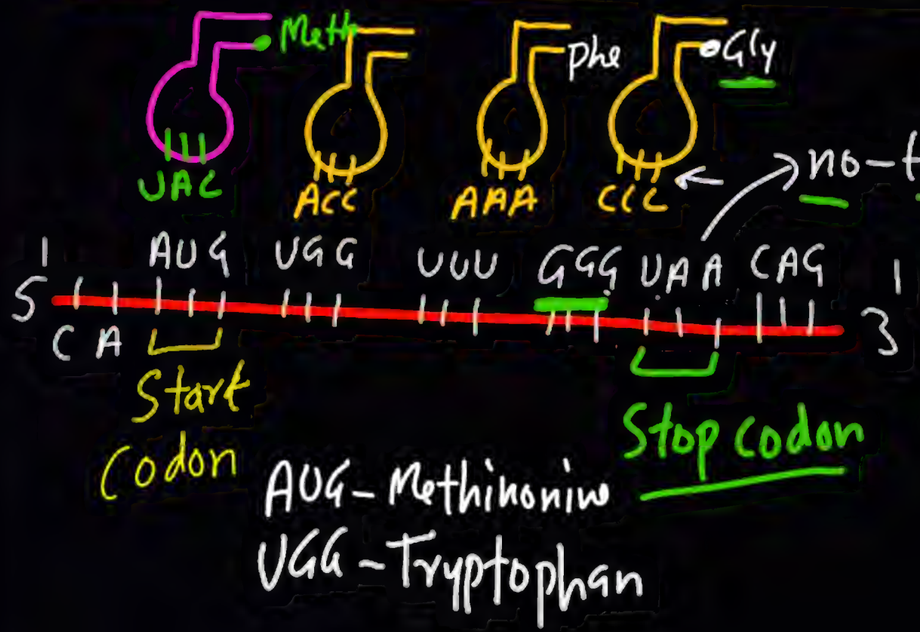
tRNA – transfer RNA

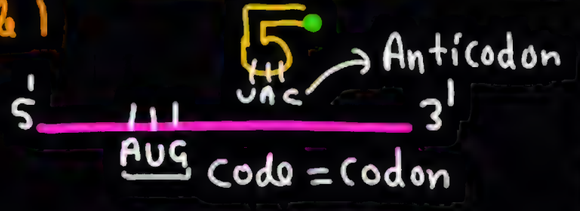
Soluble RNA / Adapter Molecule

Genetic code → Three nucleotide – AUG → Methionine
One Amino acid code UGG – Tryptophan

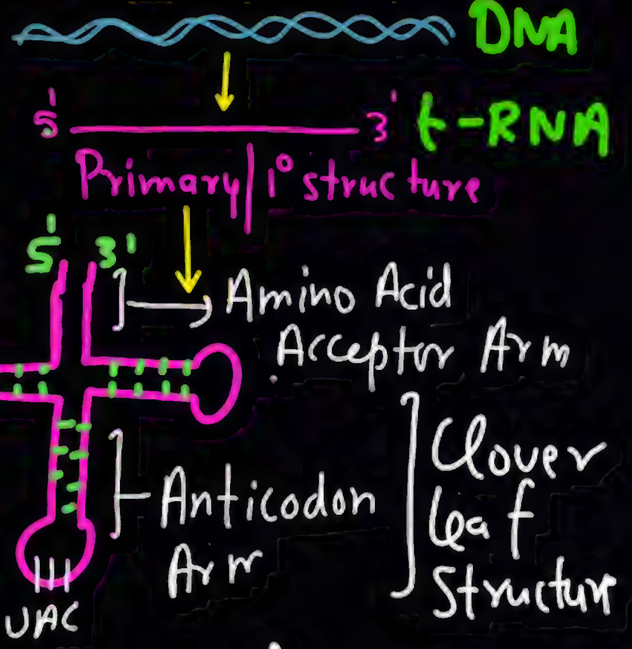
Adaptor hypothesis – Crick
- Amino Acid can not Read Code on mRNA (not have Ability)
- Acc. to crick → Some Adaptor molecule which Read code → and also Bind to Amino Acid (Bring at site of protein Synthesis (Ribosome)

t-RNA Discover → Genetic code discover → t-RNA Role Discover



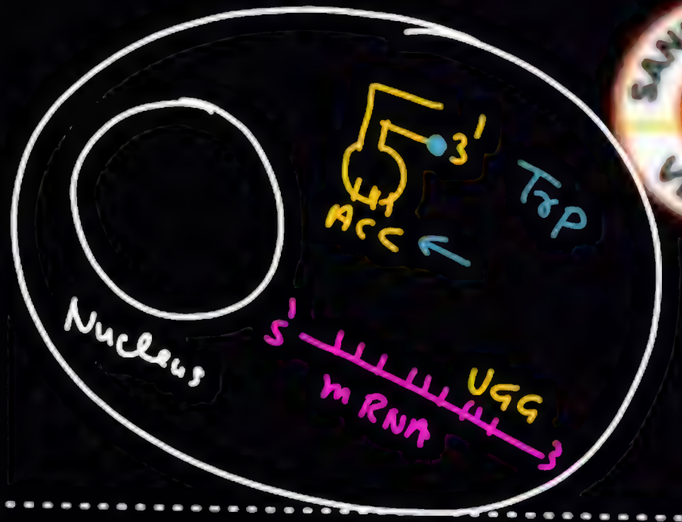


Structure of t-RNA



* Amino Acid Link → According to Anticodon | Codon
  at 3' end of t-RNA
* Initiator t-RNA – For start Codon is Different to other RNA
* No t-RNA For stop codon

- DNA Double Helix model
- Central dogma } → Crick
- Adapter hypothesis



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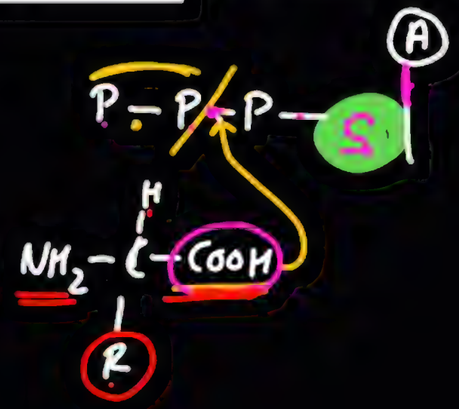
UGG – Tryptophan

Charging of RNA

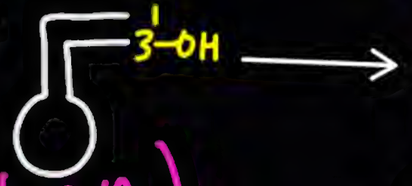
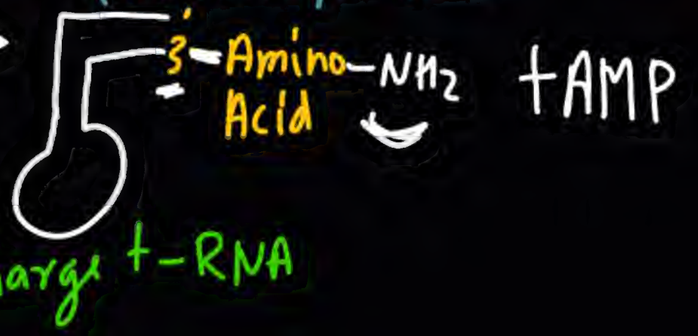
— occur in cytoplasm (Prokaryotes & Eukaryotes)

meaning → t-RNA Amino Acid (Specific Amino Acid) link

→ Energy Require



① Amino Acid + ATP ⟶ Amino Acyl AMP

② Amino Acyl AMP +  ⟶  + AMP

(Amino Acyl t-RNA

Charge t-RNA

(Enzyme – Amino Acyl t-RNA Synthase)

Comparison of RNA

Stability → rRNA > t-RNA > mRNA > hnRNA [when hnRNA to mRNA Stability Increase]

(mRNA Eukaryotes > mRNA (Prokaryotes)

Amount → rRNA > t-RNA > mRNA

(80–85%) (10–15%) (3–5%)

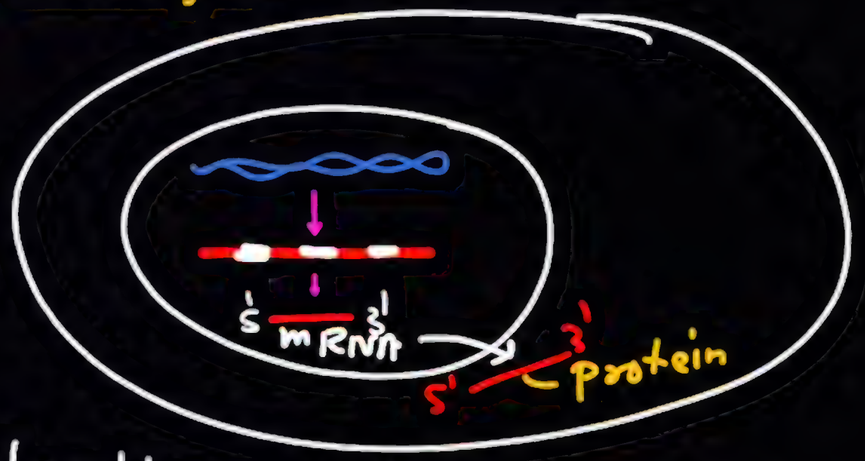
type → mRNA > tRNA > rRNA (28 S, 18 S, 5.8 S, 5 S)

(large no. of protein)

Size → t-RNA (smallest)

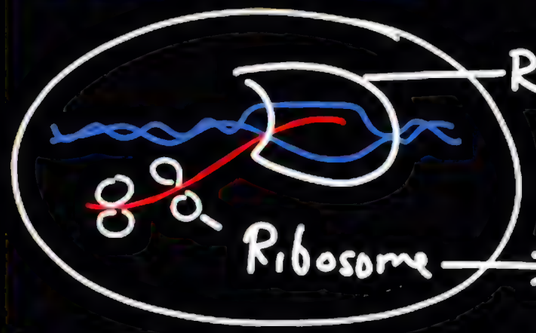
Difference in Transcription of

Eukaryotes



- Location → Nucleus
- RNA polymerase → three type (I – r, II – h, III – t)
- Stability – mRNA more stable
- PTM – Post transcriptional modification (Capping, tailing, splicing)
- Transcription – nucleus, translation – Cytoplasm] not show Both process coupled

Q Coupled transcription & translation occur in (a) E. coli (b) Yeast (c) Human cell (d) Mesophyll



Prokaryotes

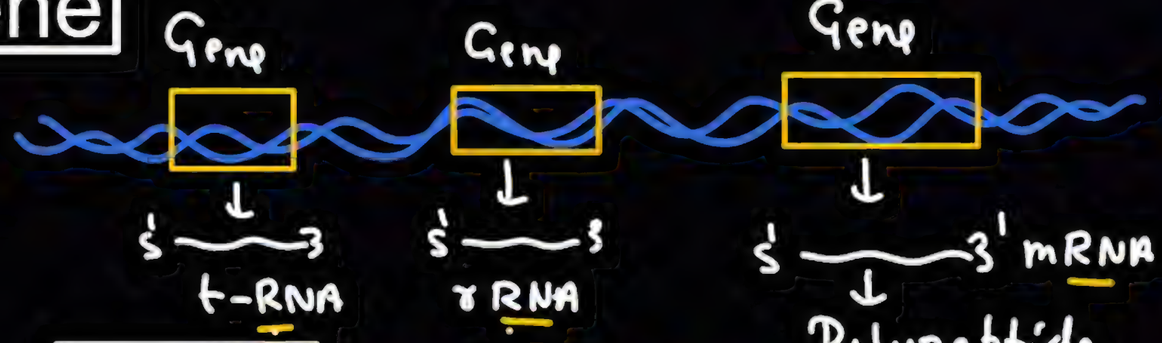
- location → Cytoplasm
- Single type of RNA polymerase transcribe all RNA
- Stability – less stable
- PTM (Modification of RNA not occur)
- Transcription & translation Coupled

Concept of Gene

→ Gene in term of Function - Easy to Define
(Gene control → trait)

→ In Form of DNA sequence it is Difficult to Define gene

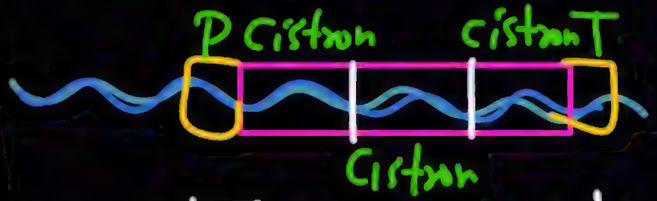
→ Gene is Sequence of DNA which code For Any type of RNA (t-RNA, mRNA, rRNA)



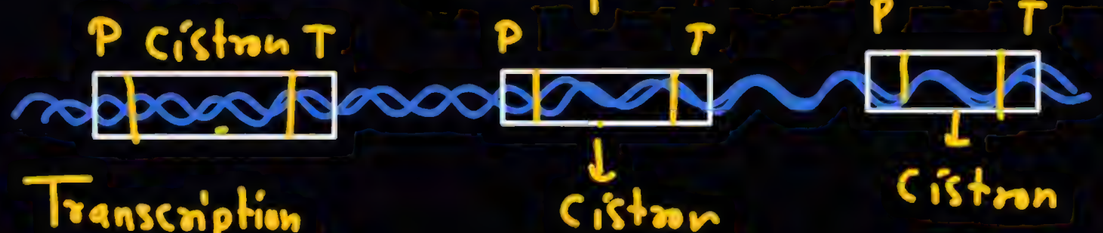
Cistron → Segment of DNA / Gene which Code For polypeptide

- All Cistrons are gene But all genes are not Cistron

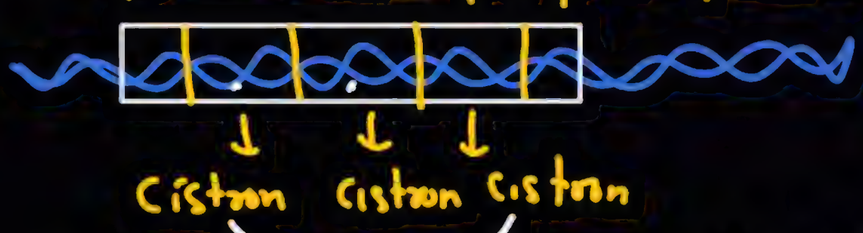
Eukaryotes → 1 transcription unit
(1 Promoter + S.G + 1 Terminator)
(Cistron)
(monocistronic)



1 Transcription unit
(many cistron
(Polycistronic)



Eukaryotes → Monocistronic



Prokaryotes - Polycistronic

Common control → all cistron Form polypeptide together

Eukaryotes → Gene → (split Gene) → means it Form hnRNA (intron & Exon Both)

↓

hnRNA (intron & Exon Both present)

Q Split gene
(a) Streptococcus
(b) Methanogen
(c) E. coli
(d) Yeast

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Molecular Basis of inheritance

lecture – 10

Botany

TARUN SIR

Topic

structure of nucleic Acid ✓ (Biomolecule) Question - 7

Discovery of DNA →

Watson and crick model →

Packaging of DNA →

Search of Genetic material → (Experiments)

DNA Replication (Experiment, Process)

Transcription – Process

Type of RNA →

Genetic code →

Translation →

Gene Expression →

Human Genome project →

DNA fingerprinting →

cell theory

DOPA - 04

Q1 Stop codon is
(a) UAA & UAG (b) not code For Any Amino Acid (c) no Specific t-RNA (d) all

Q2 Genetic code is
(a) located on mRNA (b) Located on mRNA & t-RNA (Anticodon) (c) Present on DNA (d) none

Genetic info

Q3 Non degenrate Amino Acid is —
(a) Glycine (b) Alanine (c) tryptophan (d) valine

UGG

Q4 GGG code For Glycine in Diatom, Yeast, Pila and Human means genetic code is
(a) Universal (b) Comma free (c) Unambiguous (d) all

Q5 Cell Free Synthesis of protein By
(a) Ochoa (b) Nirenberg (c) Crick (d) all

Q6 If Genetic code was Doublet then, code is possible For —— Amino Acid
(a) 20 A·A (b) 18 A·A (c) 15 A·A (d) 10

max

1 codon – 3 nucleotide

Q7 In a protein of 200 Amino acid, minimum no. of codon on mRNA

(a) 200 (b) 300 (c) 100 (d) 201 (200 code + 1 Stop codon)

Q8 In a protein of 100 Amino Acid, minimum no. of nucleotide on mRNA

(a) 303 (b) 300 (c) 600 (d) 100 → 100 × 3 = 300 nucleo

Q9 mRNA code for polypeptide of 200 Amino Acid then, mutation like Deletion occur at 301 nucleotide then

(a) Frame shift mutation occur (b) After 100 Amino Acid all Amino Acid Change

(c) only 101 Amino Acid change (d) Both a & c

Q10 mutation occur at 31 position (Addition) lead to Formation of stop codon (If original polypeptide was of 30 Amino Acid then) How much new polypeptide shorter

(a) 20 (b) 30 (c) 10 (d) 100

1 codon – 3 nucleotide

Q7 In a protein of 200 Amino acid, minimum no. of codon on mRNA
(a) 200 (b) 300 (c) 100 (d) 201 (200 code + 1 stop codon)

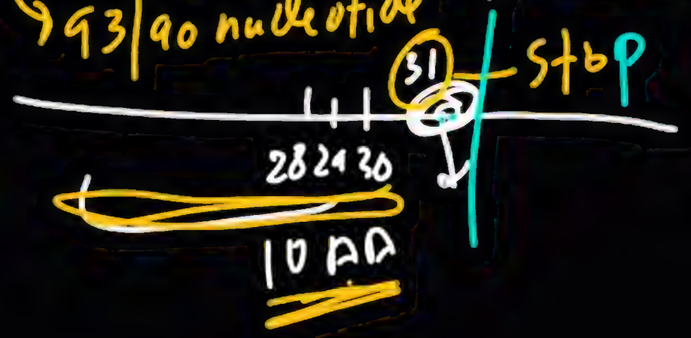
200 A.A → 600 nucleoth

Q8 In a protein of 100 Amino Acid, minimum no. of nucleotide on mRNA
(a) 303 (b) 300 (c) 600 (d) 100 → 100 × 3 = 300 nucleotide

Q9 mRNA code for polypeptide of 200 Amino Acid then, mutation like Deletion occur at 301 nucleotide then → 600
(Frame shift)
(a) Frame shift mutation occur after 100 Amino Acid all Amino Acid Change
(c) only 101 Amino Acid change (d) Both a & b

Q10 mutation occur at 31 position (Addition) lead to Formation of stop codon (If original polypeptide was of 30 Amino Acid then) How much new polypeptide shorter
(a) 20 (b) 30 (c) 10 (d) 100

→ 93/90 nucleotide

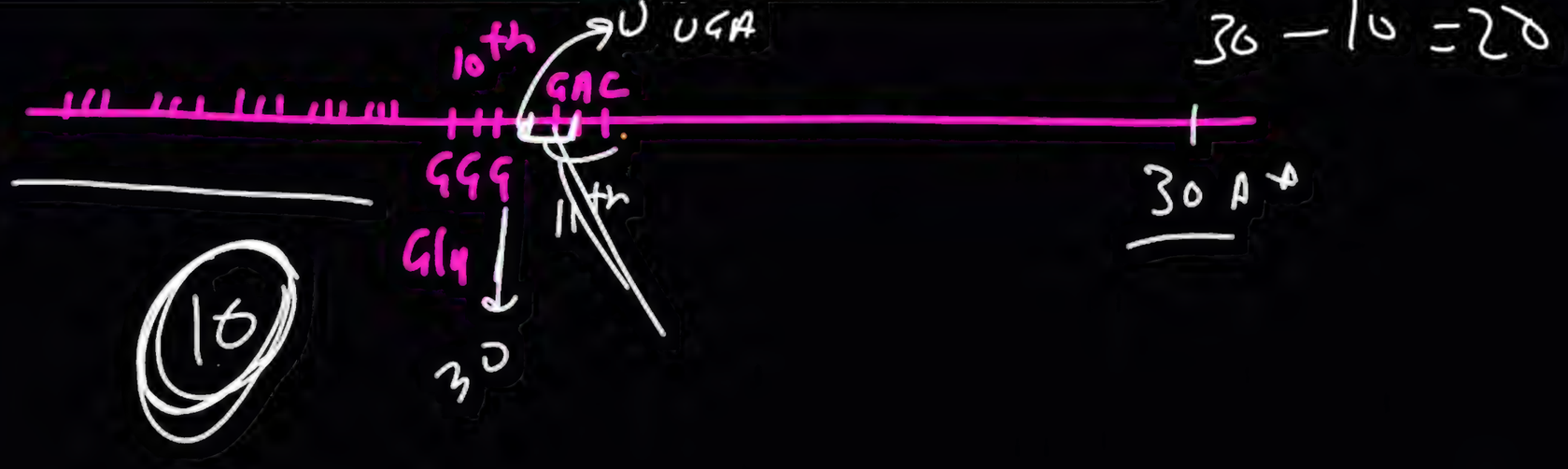


RAM HAS RED CAP

RAM HAS BRE DCA P

RAM HAS BIR EDC AP

RAM HAS BIG RED CAP



RAM HAS EDC AP

RAM HAS DCA P

RAM HAS CAP

The conclusion from the above exercise is very obvious. Insertion or deletion of one or two bases changes the reading frame from the point of insertion or deletion. However, such mutations are referred to as

Translation

Process – Information of mRNA (in form of code) is translated into Sequence of Amino Acid
(mRNA ⟶ Polypeptide chain

location ⟶ Cytoplasm → Prokaryotes → 70 S Ribosome
Cytoplasm – Eukaryotes – 80 S Ribosome
– matrix of mitochondria & stroma of chloroplast

Requirement ⟶ mRNA, t-RNA, r RNA (ribosome)

- **Sequence of Amino Acid determine By** Sequence of nucleotide in DNA & mRNA
- Process Endothermic – Charging of t-RNA – use ATP

steps – Polypeptide chain → Heteropolymer
(Synthesis three step)
(a) Initiation (b) Elongation (c) Termination

[UTR – Untranslated Region]

- Present on mRNA

- Present at 5' end before start codon & at 3' end after stop codon

Role – help in Efficient translation

Q Endothermic is
(a) Transcription (b) Reverse transcription
(c) Translation (d) Replication
(e) all

Translation

Process – Information of mRNA (in form of code) is translated into Sequence of Amino Acid
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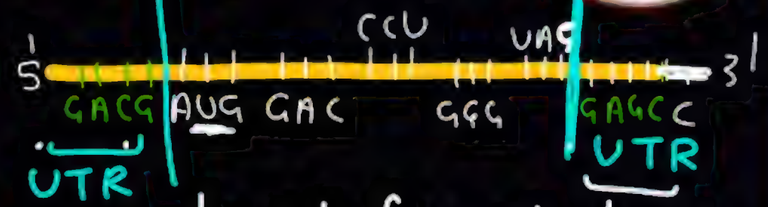

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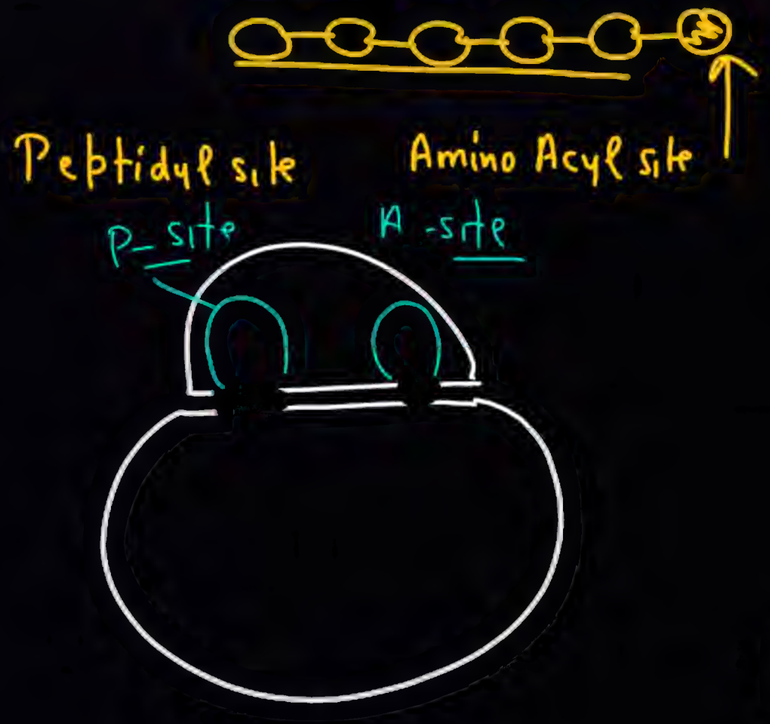
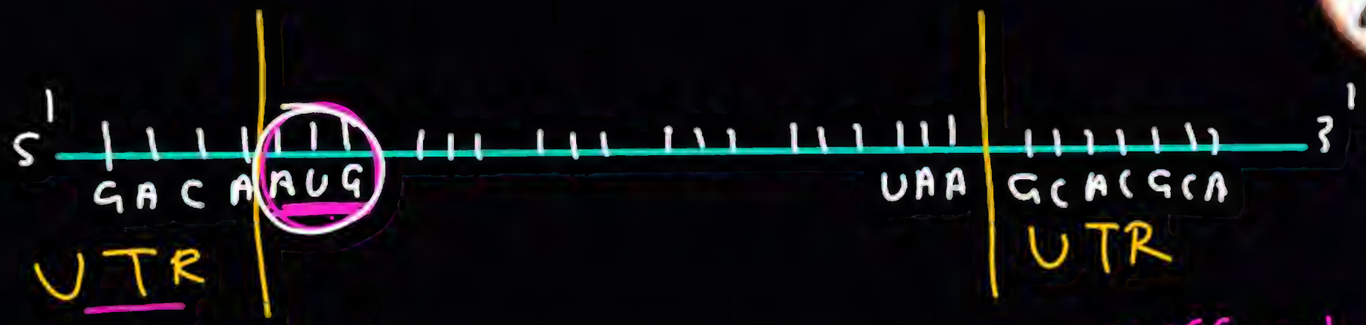




1 mRNA ⟶ 3 Frame ⟶ 3 polypeptide (Different)

Code

→ But Always only one Form

No start codon → No UTR

↓

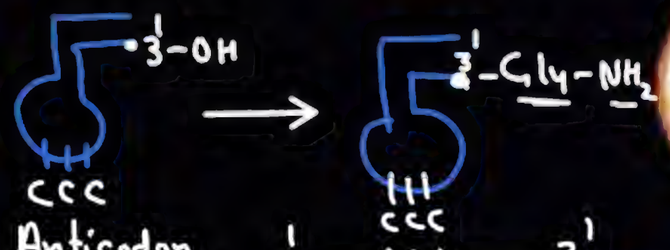
3 type protein Form

↓

33% Efficient

Steps in translation

- Charging of t-RNA → ATP + Amino Acid ⟶ Amino Acyl AMP
  (First step)
  Amino Acyl AMP + t-RNA ⟶ Amino Acyl t-RNA
  (Charge t-RNA)



* Charging Require ATP
* 3° structure of tRNA → Specific Amino Acid → COOH Group attach at 3'-end
* Enzyme - Amino Acyl t-RNA Synthetase

I initiation

Cytoplasm (mRNA)

mRNA + Small Subunit (30 S)

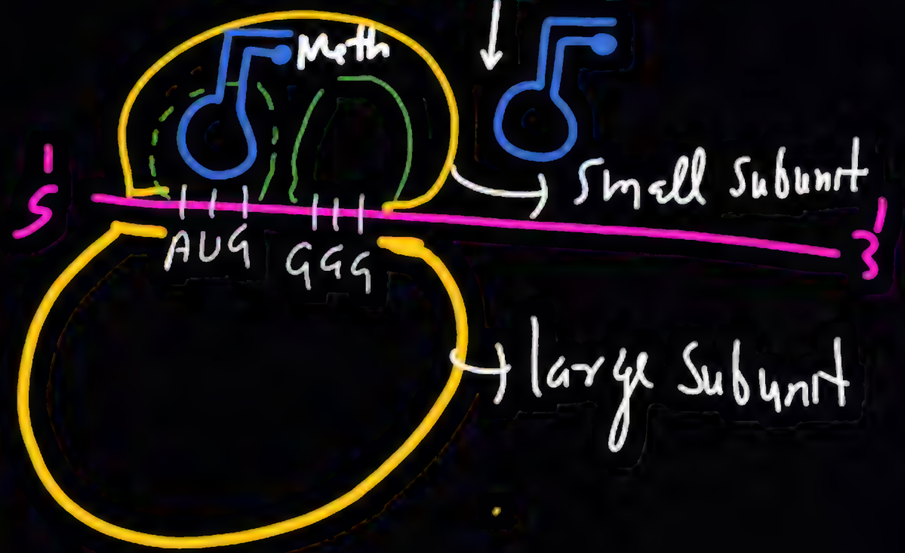
↓

mRNA · Small subunit + Charge t-RNA (P-site on Ribosomp)

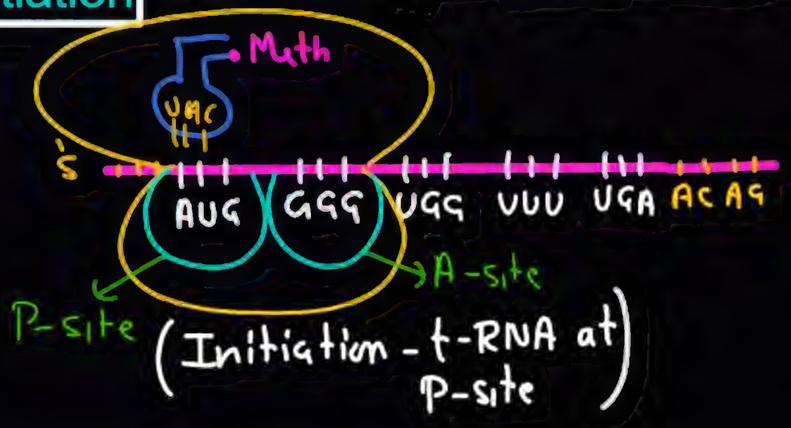
↓ 50 S subunit

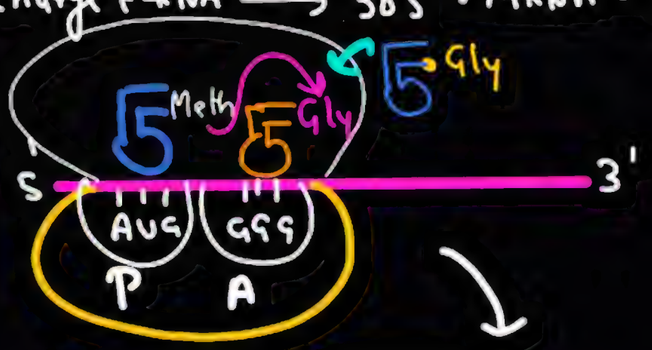
mRNA · 30 S subunit · Charge t-RNA · large Subunit

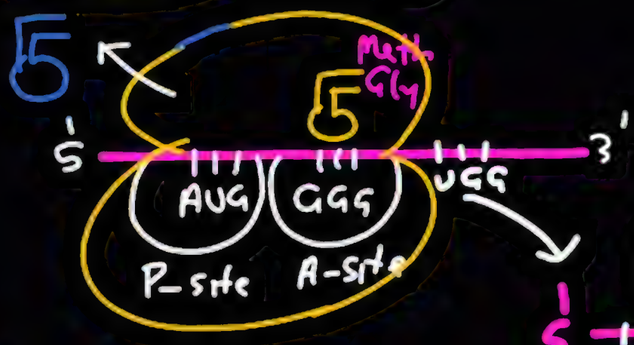
(Small

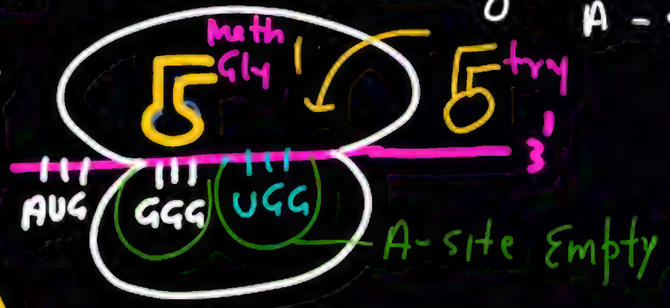


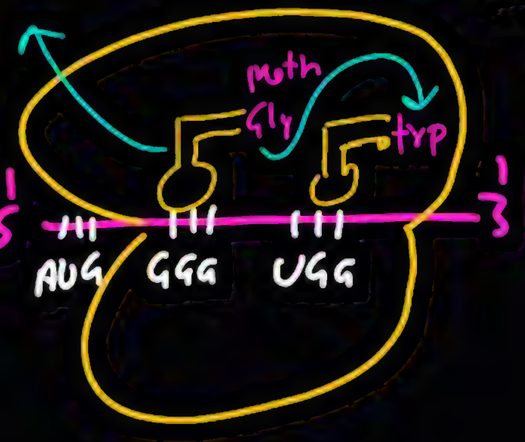
Initiation – 30s + mRNA ⟶ 30S · mRNA + Charge t-RNA ⟶ 30s · mRNA · t-RNA · large unit

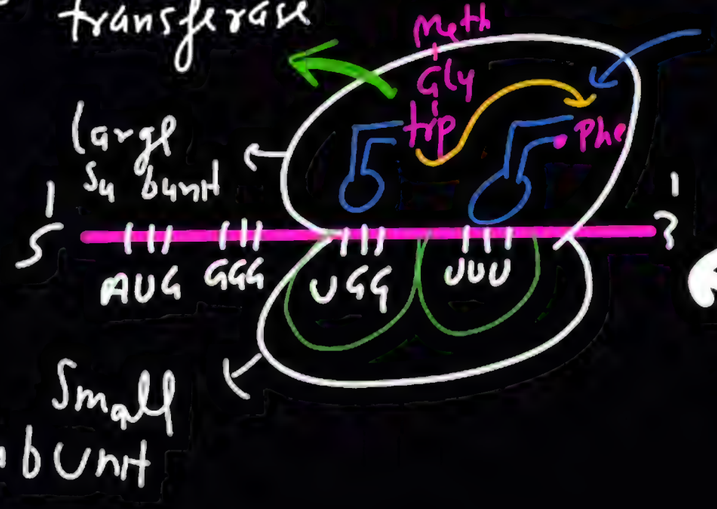












Elongation →

- Charge t-RNA → A-site
- Peptide Bond Form
- P-site t-RNA (leave) Empty
- Ribosome move Forward
  → A-site Empty
  → charge t-RNA come at A-site

Elongation – Ribosome move one step with Each peptide Bond

Initiation (Charge t-RNA on P-site (no peptide Bond Form)

Charge t-RNA Comes at A-site

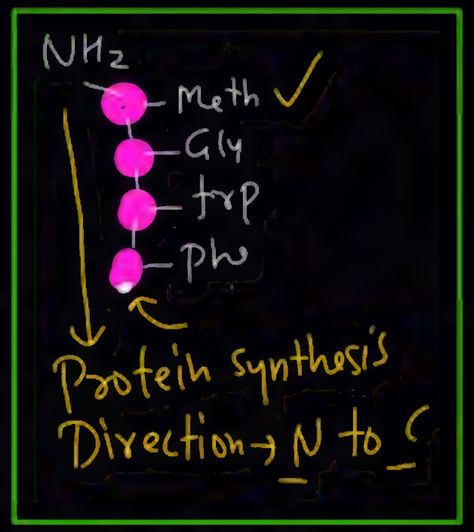
Peptide Bond Form (Amino Acid/Peptide chain Transfer From P-site to A-site

t-RNA of P-site Empty

t-RNA leave From P-site

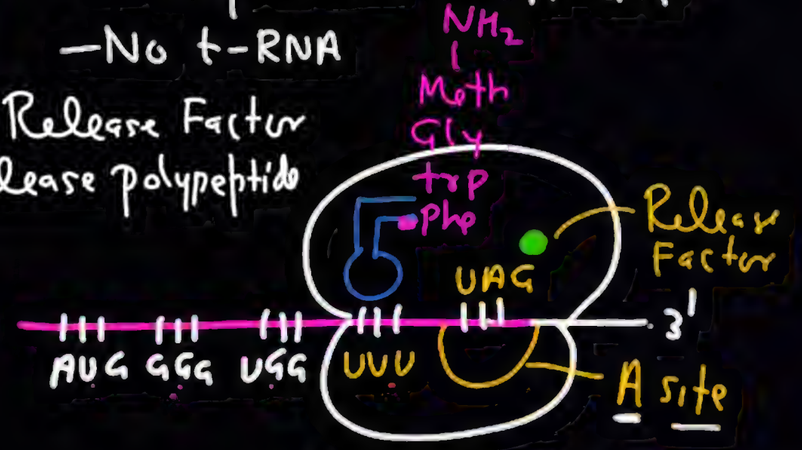
Ribosome move one step

A site Empty



Termination

– Stop codon on A-site
– No t-RNA
→ Release Factor
Release polypeptide



note – Peptide Bond → Formed By Enzyme → Peptidyl transferase (Ribozyme – large Subunit Present on)

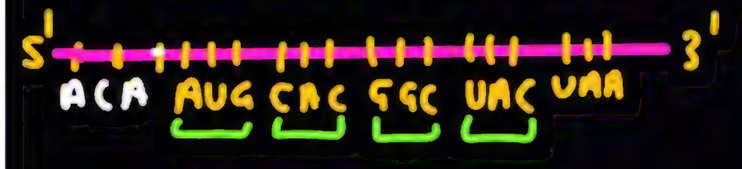
(type of RNA → 23 S rRNA – E. Coli
28 S rRNA – Yeast)

– Charge t-RNA (P site & A-site Both are Close) → help in Bond Formation (Peptide Bond)

5.7 Translation

Translation refers to the process of polymerisation of amino acids to form a polypeptide (Figure 5.13). The order and sequence of amino acids are defined by the sequence of bases in the mRNA. The amino acids are joined by a bond which is known as a peptide bond. Formation of a peptide bond requires energy. Therefore, in the first phase itself amino acids are activated in the presence of ATP and linked to their cognate tRNA–a process commonly called as **charging of tRNA** or **aminoacylation of tRNA** to be more specific. If two such charged tRNAs are brought close enough, the formation of peptide bond between them

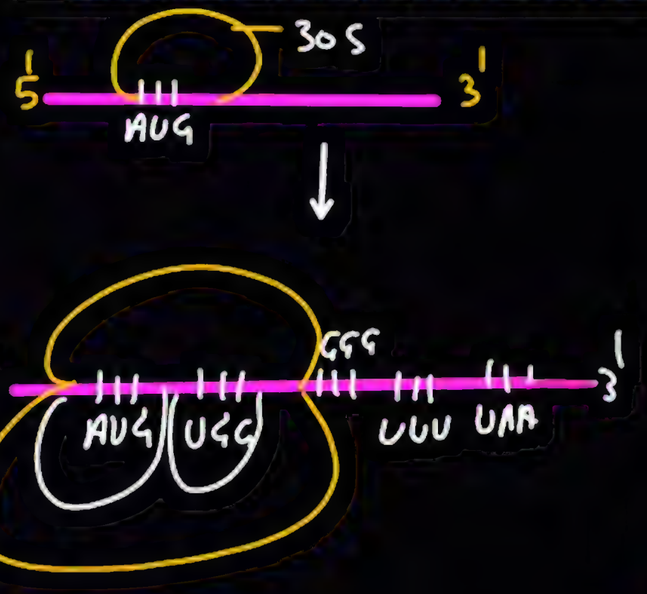
A translational unit in mRNA is the sequence of RNA that is flanked by the start codon (AUG) and the stop codon and codes for a polypeptide. An mRNA also has some additional sequences that are not translated and are referred as **untranslated regions** (**UTR**). The UTRs are present at both 5′-end (before start codon) and at 3′-end (after stop codon). They are required for efficient translation process.

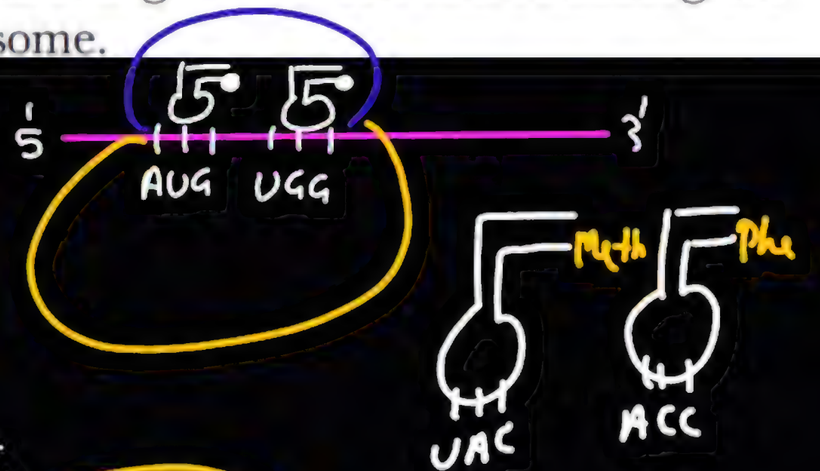


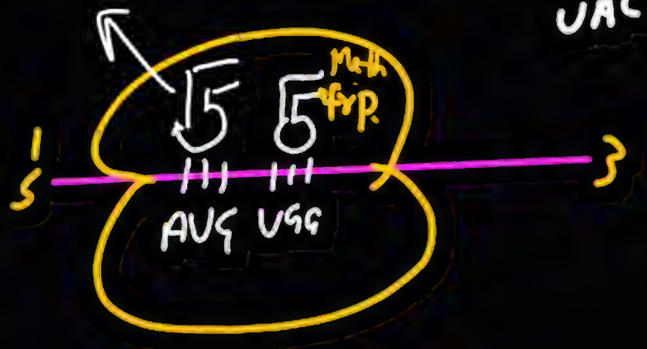
* UTR is located at → 5' end
  3' end
* Use →
* mRNA → 90 nucleotide (5 codon at 5' end
  5 codon at 3' end UTR

total Amino Acid

For initiation, the ribosome binds to the mRNA at the start codon (AUG) that is recognised only by the initiator tRNA. The ribosome proceeds to the elongation phase of protein synthesis. During this stage, complexes composed of an amino acid linked to tRNA, sequentially bind to the appropriate codon in mRNA by forming complementary base pairs with the tRNA anticodon. The ribosome moves from codon to codon along the mRNA. Amino acids are added one by one, translated into Polypeptide sequences dictated by DNA and represented by mRNA. At the end, a **release factor** binds to the stop codon, terminating translation and releasing the complete polypeptide from the ribosome.







DOPA

Q1 Ribozyme is located in

(a) t-RNA (b) mRNA (c) rRNA (d) all

Q2 Peptidyl transferase present in

(a) Ribosome (b) 23 S rRNA in E.coli (c) 28 S rRNA in yeast (d) all

Q3 UTR is

(a) Protein (b) nucleic Acid with deoxyribose (c) Part of mRNA (d) all

Q4 For initiation mRNA link to

(a) 30 S Subunit (b) 50 S Subunit (c) tRNA (d) rRNA

Q5 Peptide Bond Form in

(a) initiation (b) Elongation (c) Termination (d) all

Q6 Charge t-RNA come at ___ site in initiation step

(a) A-site (b) P-Site (c) none (d) Both

Q7 termination step stop codon at

(a) A site (b) P site (c) all (d) Both

Q8 Chain termination in termination is helped By in translation

(a) Elongation Factor (b) Release Factor (c) Rho factor (d) all

Q9 Number of protein in 80s ribosome is

(a) 70 (b) 30 (c) 40 (d) 60

Q10 When P-site Empty then ___ occur in Elongation

(a) New t-RNA Comes (b) Ribosume move Forward (c) New t-RNA Come at A-site (d) Peptide Bond Form

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Molecular Basis of inheritance

lecture –

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TARUN SIR

Topic

structure of nucleic Acid ✓ (Biomolecule) Question - 7

Discovery of DNA →

Watson and crick model →

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Search of Genetic material → (Experiments)

DNA Replication (Experiment, Process)

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Type of RNA →

Genetic code →

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Q6 Charge t-RNA come at ___ site in initiation step

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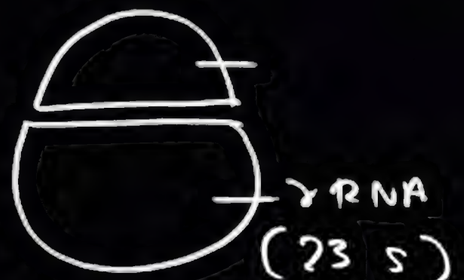


Q7 termination step stop codon at

(a) A site (b) P site (c) all (d) Both

Q8 Chain termination in termination is helped By in translation

(a) Elongation Factor (b) Release Factor (c) Rho factor (d) all

Q9 Number of protein in 80 S ribosome is

(a) 70 (b) 30 (c) 40 (d) 80

Q10 When P-site Empty then ___ occur in Elongation

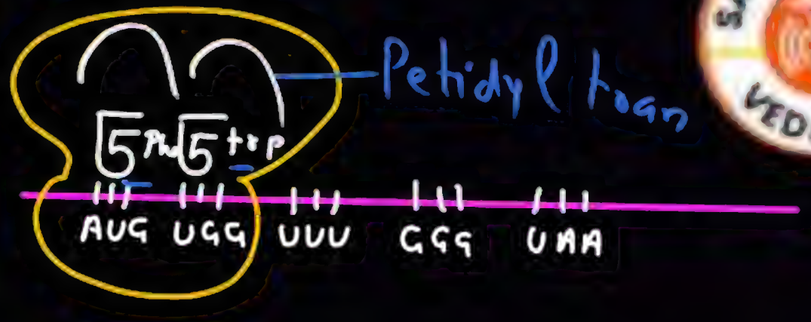
(a) New t-RNA Comes (b) Ribosume move Forward (c) New t-RNA come at A-site (d) Peptide Bond Form

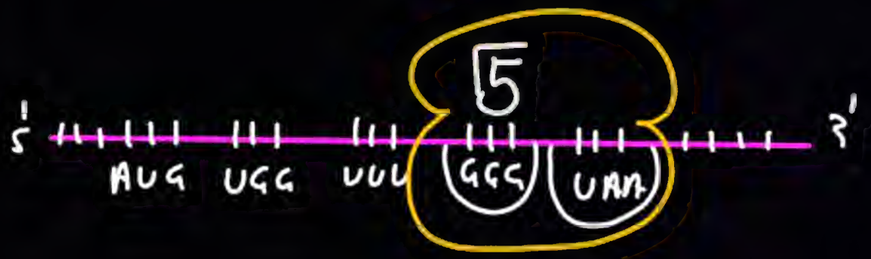
5.7 Translation

Translation refers to the process of polymerisation of amino acids to form a polypeptide (Figure 5.13). The order and sequence of amino acids are defined by the sequence of bases in the mRNA. The amino acids are joined by a bond which is known as a peptide bond. Formation of a peptide bond requires energy. Therefore, in the first phase itself amino acids are activated in the presence of ATP and linked to their cognate tRNA–a process commonly called as **charging of tRNA** or **aminoacylation of tRNA** to be more specific. If two such charged tRNAs are brought close enough, the formation of peptide bond between them

would be favoured energetically. The presence of a catalyst would enhance the rate of peptide bond formation.

The cellular factory responsible for synthesising proteins is the ribosome. The ribosome consists of structural RNAs and about 80 different proteins. In its inactive state it exists as two subunits: a large subunit and a small subunit. When the small subunit encounters an mRNA, the process of translation of the mRNA to protein begins. There are two sites in the large subunit, for subsequent amino acids to bind to and thus, be close enough to each other for the formation of a peptide bond. The ribosome also acts as a catalyst (23S rRNA in bacteria is the enzyme - ribozyme) for the formation of peptide bond.





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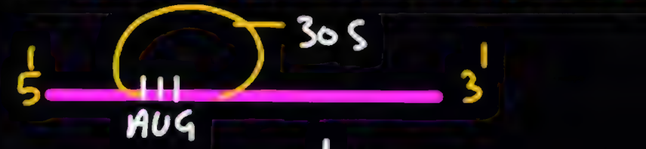
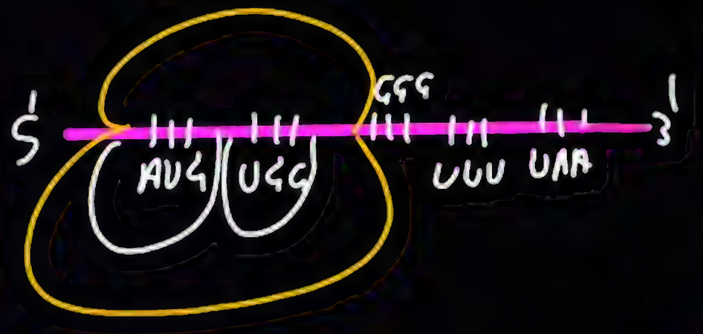
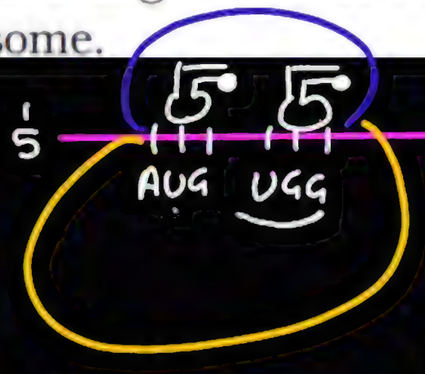
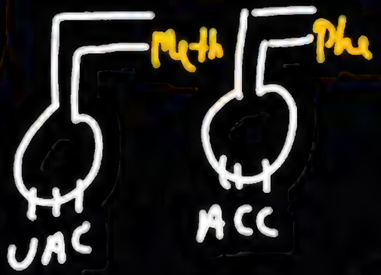
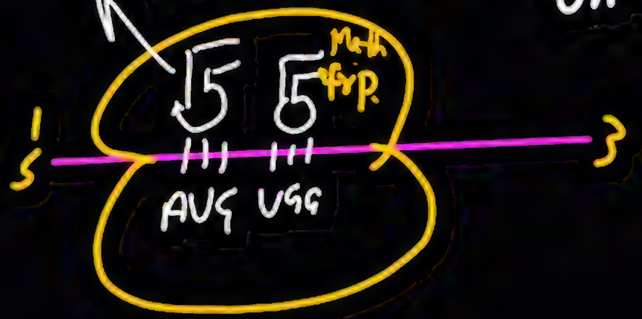
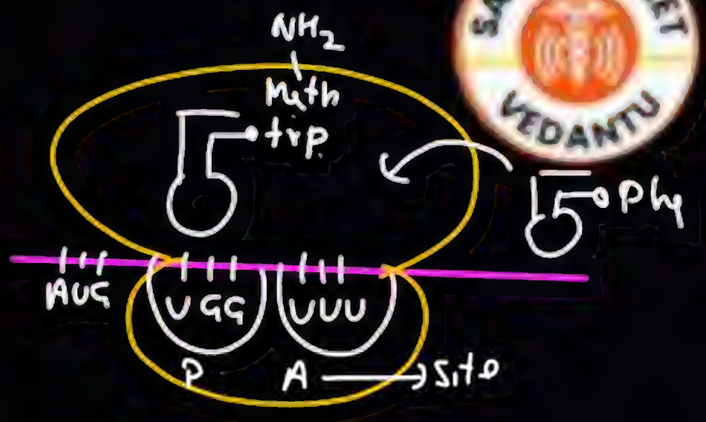


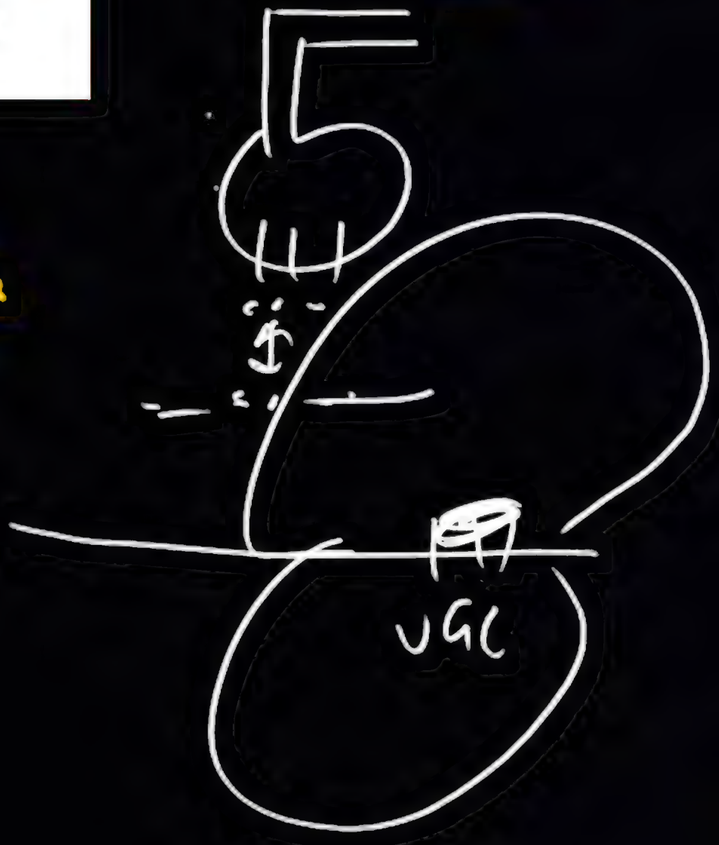


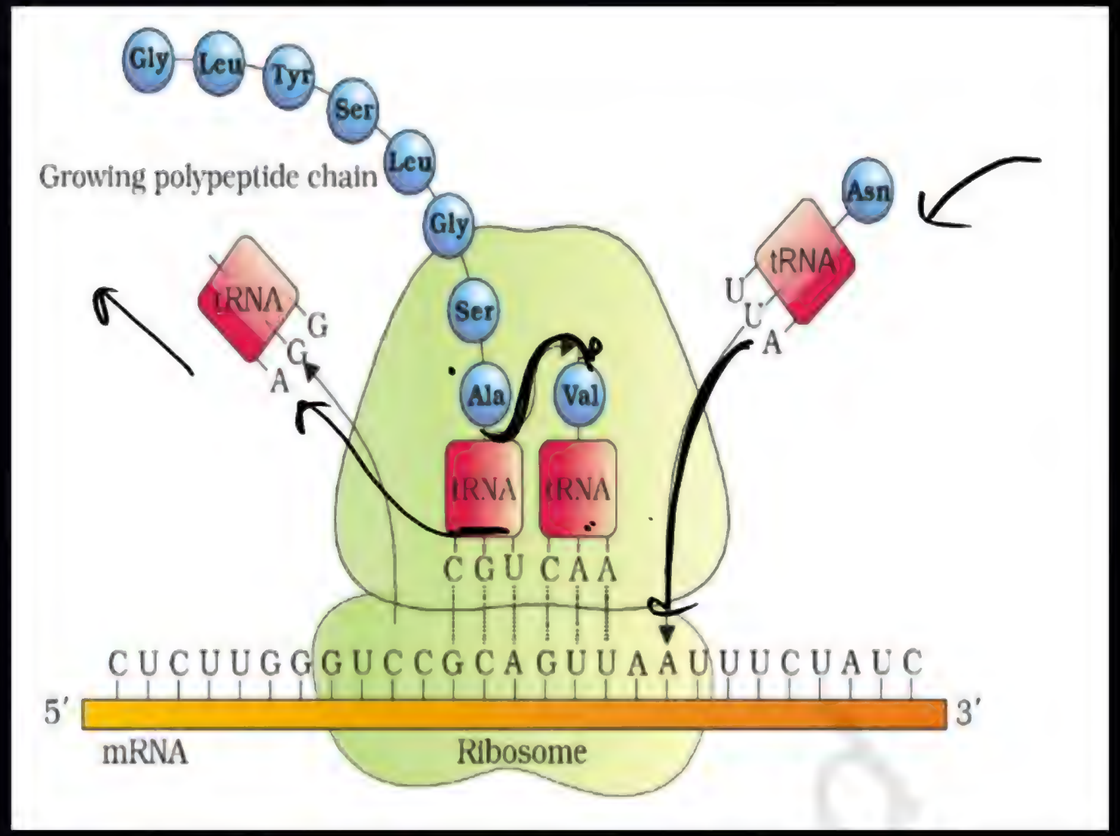











Gly
Leu
Tyr
Ser
Leu
Gly
Ser
Ala
Val
Growing polypeptide chain
tRNA
G
C
A
tRNA
tRNA
C G U C A A
Asn
tRNA
U
U
A
C U C U U G G G U C C G C A G U U A A U U U C U A U C
5′
3′
mRNA
Ribosome

A translational unit in mRNA is the sequence of RNA that is flanked by the start codon (AUG) and the stop codon and codes for a polypeptide. An mRNA also has some additional sequences that are not translated and are referred as **untranslated regions** (**UTR**). The UTRs are present at both 5′-end (before start codon) and at 3′-end (after stop codon). They are required for efficient translation process.

Regulation of Gene Expression

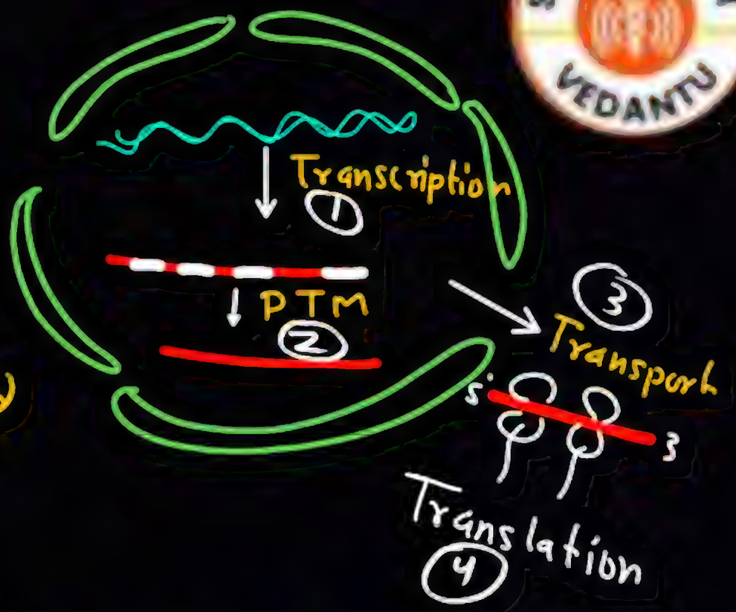
↓ control ↓ Protein Synthesis

meaning → How protein synthesis control

Eukaryotes 4 Level of control → In Eukaryotes Final protein → 4 steps

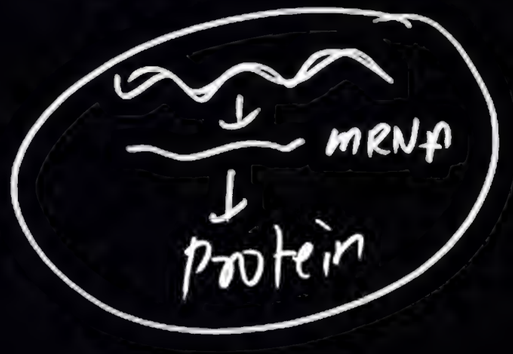
(a) Transcription ✓
(b) Post transcriptional modification ✓
(3) Transport of mRNA (nucleus to cytoplasm) ✓
(4) Translation ✓

— Any one step Block → Protein not Form



Procaryotes → Modification and Transport not occur (only two level of control)

(a) transcription → main control
(b) Translation at transcription level



5.8 Regulation of Gene Expression

Regulation of gene expression refers to a very broad term that may occur at various levels. Considering that gene expression results in the formation of a polypeptide, it can be regulated at several levels. In eukaryotes, the regulation could be exerted at

(i) transcriptional level (formation of primary transcript),

(ii) processing level (regulation of splicing),

(iii) transport of mRNA from nucleus to the cytoplasm,

(iv) translational level.

Why need Regulation

Explains By Example

- E.coli → Can use lactose From medium For Energy
- Lactose (Diasaccharidic) (Glycosidic Bond → Metabolise By → use of Enzyme B-Galactose

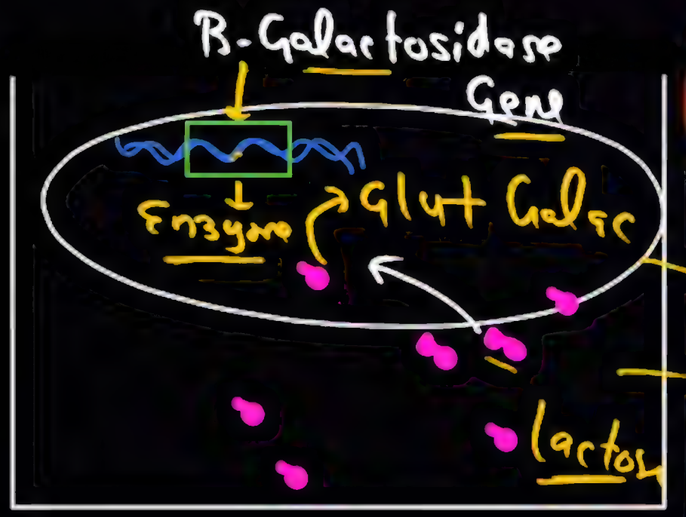
- (If lactose present in medium – β-galactosidase Require (Metabolic need)

- Why need Regulation → Due to Enviornment need ✓ Metabolic need ✓, Physiological need

- Developmental need → Due to which some Gene Express

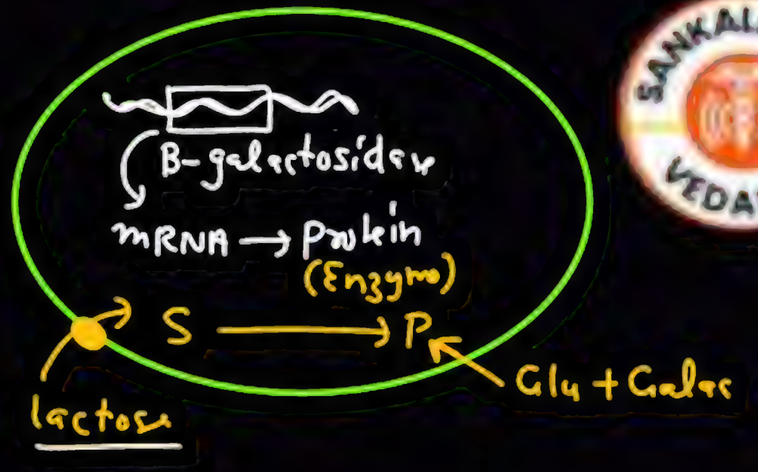
⊙ Zygote → Morula → Blastocyst → Embry

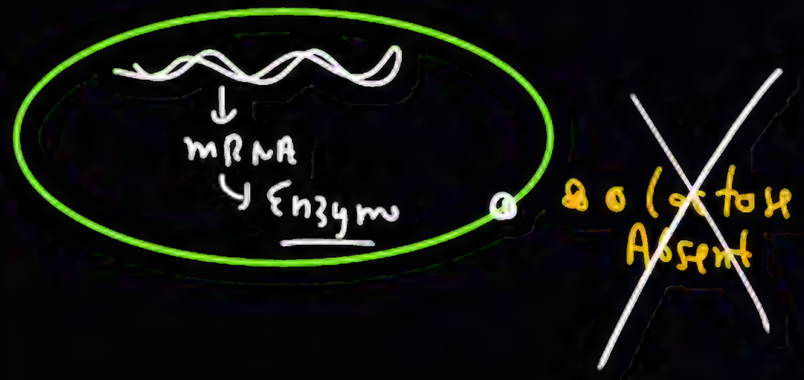
(Expression of Gene ↑ in coodination to control development)



SANKALP NEET VEDANTU

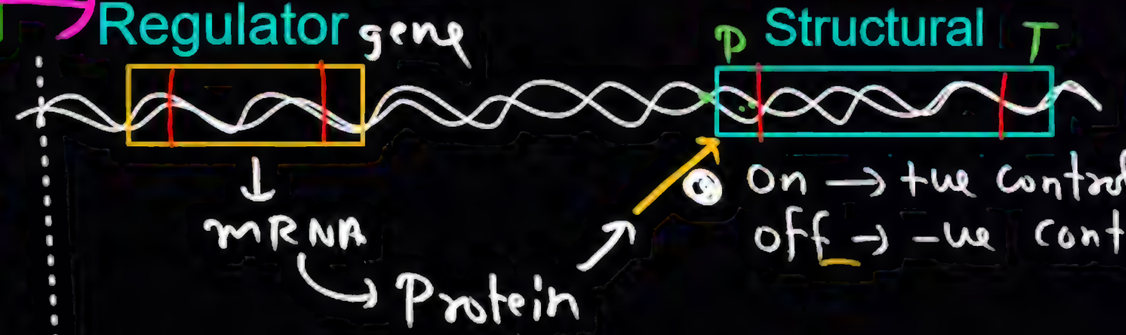
The genes in a cell are expressed to perform a particular function or a set of functions. For example, if an enzyme called beta-galactosidase is synthesised by *E. coli*, it is used to catalyse the hydrolysis of a disaccharide, lactose into galactose and glucose; the bacteria use them as a source of energy. Hence, if the bacteria do not have lactose around them to be utilised for energy source, they would no longer require the synthesis of the enzyme beta-galactosidase. Therefore, in simple terms, it is the metabolic, physiological or environmental conditions that regulate the expression of genes. The development and differentiation of embryo into adult organisms are also a result of the coordinated regulation of expression of several sets of genes.





Requirement of Gene Expression → ① Metabolic need
② Physiological & Environment

Type of Gene



I Regulator
- gt produce protein which control Expression of other Gene (Control structural Gene

II Structural
- gt produce Enzymes

III

Constitutive (Housekeeping gene) – gt Always Express, gt never Under control
Ex → Regulator gene, gene For t-RNA & mRNA necessary mRNA → Hexokinase, Pyruvate Kinase (Essential process gene

non constitutive → Gene which not Always Express Under control of Regulator gene

Type of Regulation

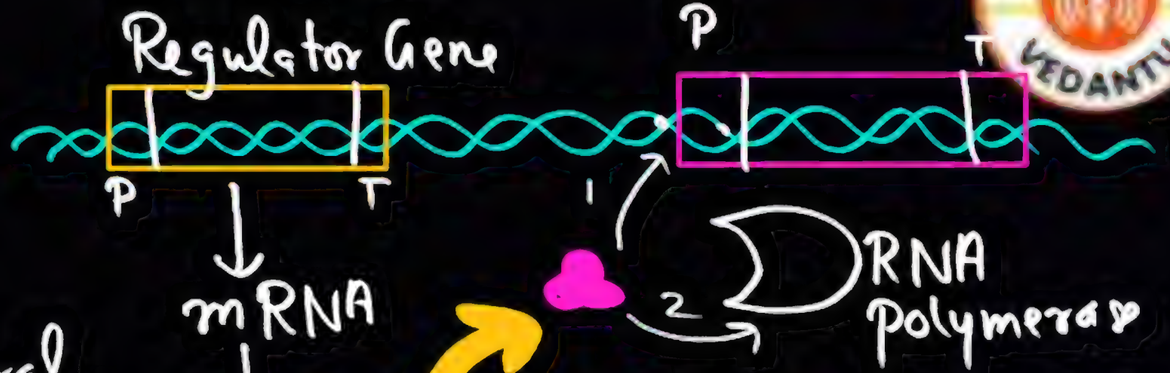
(a) Positive Regulation : Regulator protein Switch on Structural Gene

(Regulator protein is Activator)

(b) Negative Regulation – Regulator Protein Switch off on Structural Gene

– Regulator protein → named as Repressor

note – Some structural Gene is Constitutive



(–ve Regulation)

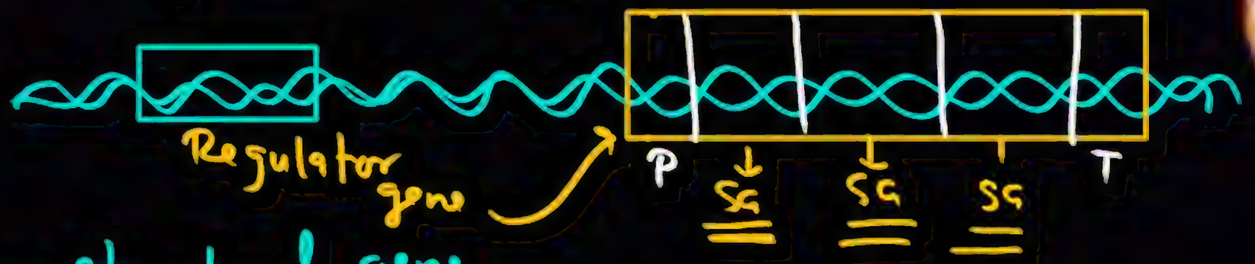
Regulator Protein → two type Act

(a) Bind on Regulatory Sequence (Present Close to promoter (Prevent RNA polymerase to Bind)

(b) It Bind to RNA polymerase Prevent transcription

Control in prokaryotes

(main control) ⇒ Transcription level



Polycistronic → In prokaryotes → many structural gene
Single promoter → all Gene Active together ✓
(Structure
↳ Benefit - all genes in common promoter → part of same metabolic pathway

meaning of operon → Type of control → One Regulator gene control many Structural Gene
(Arrangent

operon only possible in prokaryotes → Reason (Prokaryotes transcription unit is Polycistronic not in Eukaryotes)

- Operon not in Eukaryotes → Eukaryotes Transcription Unit monocitronic

Example of operon

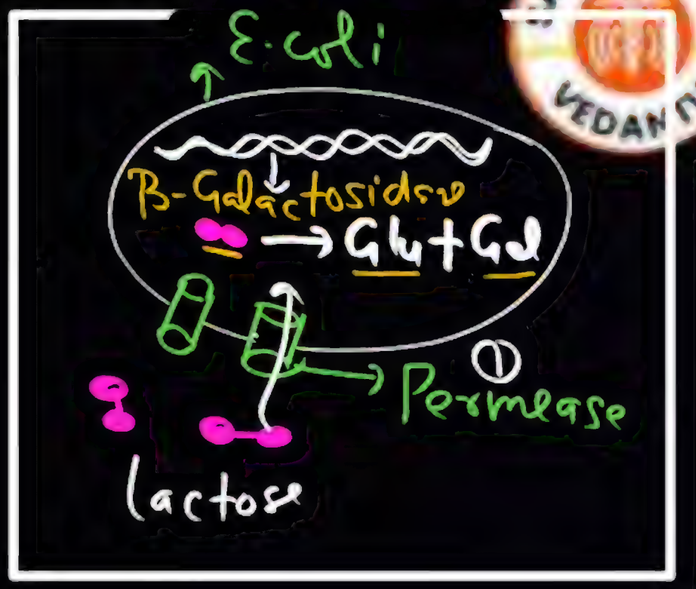
① Tryptophan operon
② Val operon ④ Arab operon
③ Lac operon → Structural Gene → lactose metabolism

How lactose metabolise By E-coli

→ lactose (Sugar) → Metabolise (Break into Glucose & Galactose)

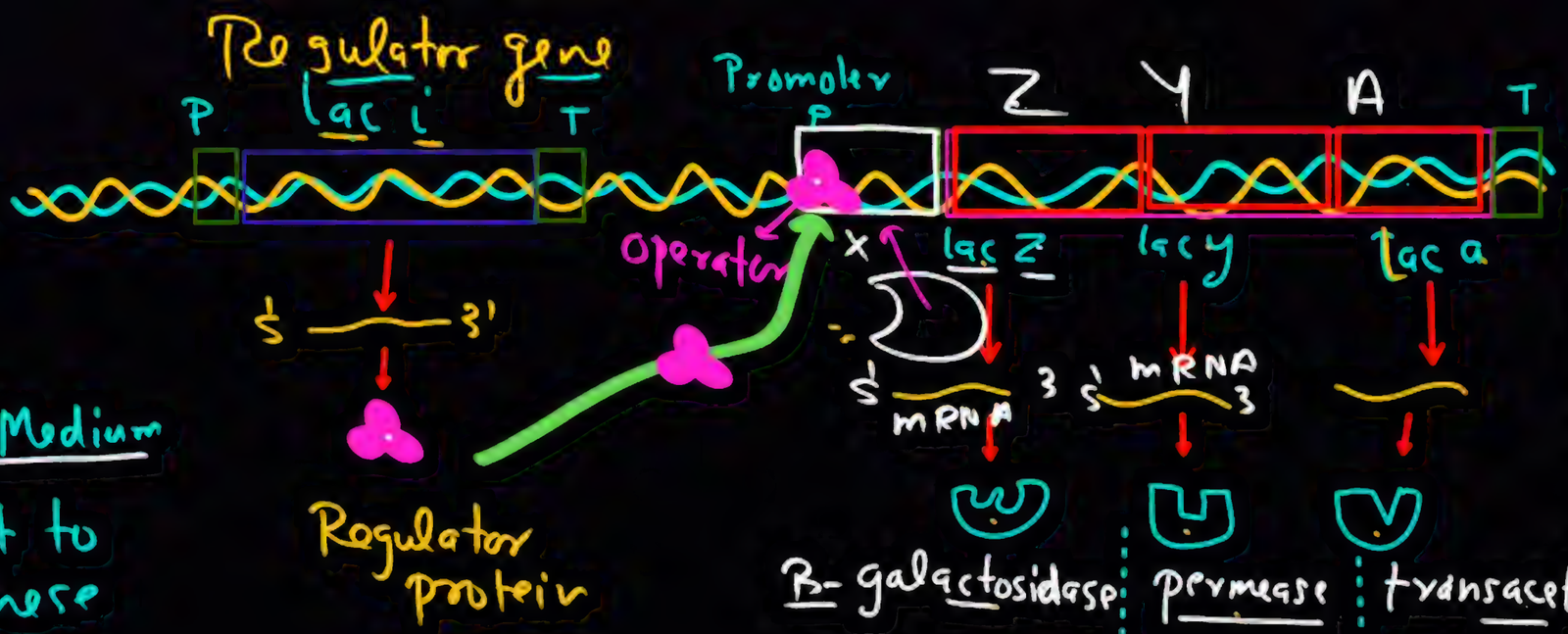
- In medium → lactose present → E. coli Require three Enzyme to break lactose

→ (a) B-galactosidase → Break Glycosidic Bond → Glu + Galac
→ (b) Permease → channel For Entry of lactose
→ (c) transacetylase → (All three Enzyme Require to use lactose)



Lac operon

- Given By - Jacob and Monod
- Explain How lactose metabolism is controlled in E. coli
- Glucose is primary source → when Glucose Absent → cell can use lactose ✓
- Lac operon →
  - Type of Regulation — Negative Regulation (Product of Regulator gene switch off operon)
  - Type of operon → operon which is in general is off But Can be Switch on → Inducible operon



Condition I

lactose Absent in Medium

↓

E.coli need not to Synthesise these Enzymes ↓

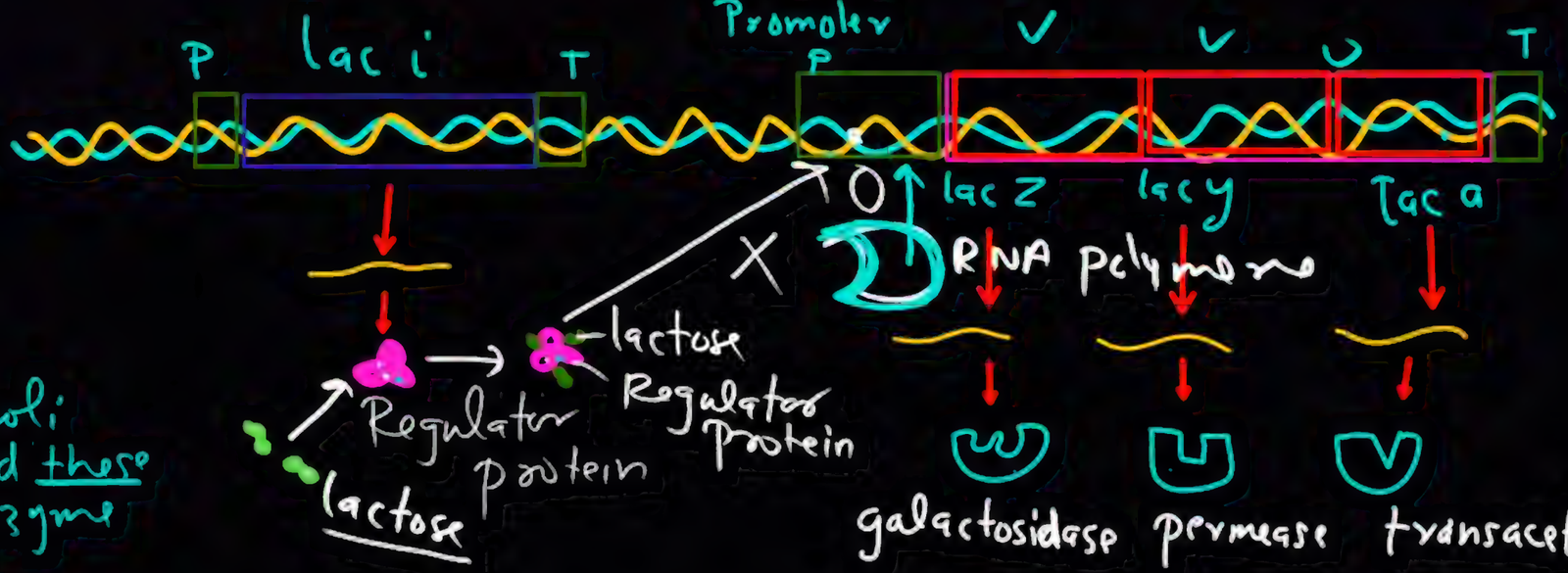
Regulator protein Bind on operator (Part of Promoter)

↓

Prevent Binding of RNA Polymerase on Promoter

↓

Transcription Stop



Condition II

lactose present in medium → E. coli need these Enzyme

↓

lactose Enter into E. coli → Bind with Regulator protein → Prevent its Binding on (Operator)

↓

RNA polymerase Bind on promoter (transcription) occur

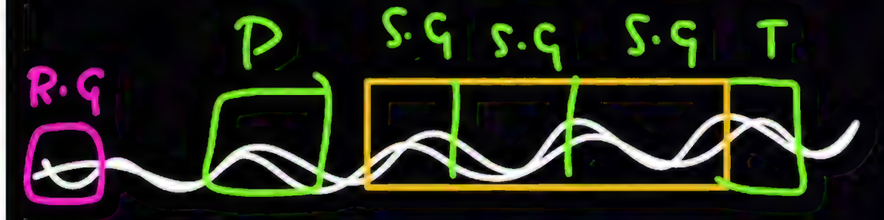
Regulator protein → Alone → Stop transcription → named as Repressor

lactose (Allolactose) → operon switch on → Inducer (lactose is Inducer)

note - Small level of lac operon → Always Express)

expression of several sets of genes.

In prokaryotes, control of the rate of transcriptional initiation is the predominant site for control of gene expression. In a transcription unit, the activity of RNA polymerase at a given promoter is in turn regulated by interaction with accessory proteins, which affect its ability to recognise start sites. These regulatory proteins can act both positively (activators) and negatively (repressors). The accessibility of promoter regions of prokaryotic DNA is in many cases regulated by the interaction of proteins with sequences termed **operators**. The operator region is adjacent to the promoter elements in most operons and in most cases the sequences of the operator bind a repressor protein. Each operon has its specific operator and specific repressor. For example, *lac* operator is present only in the *lac* operon and it interacts specifically with *lac* repressor only.



lactose

The repressor of the operon is synthesised (all-the-time – constitutively) from the *i* gene. The repressor protein binds to the operator region of the operon and prevents RNA polymerase from transcribing the operon. In the presence of an inducer, such as lactose or allolactose, the repressor is inactivated by interaction with the inducer. This allows RNA polymerase access to the promoter and transcription proceeds (Figure 5.14). Essentially, regulation of *lac* operon can also be visualised as regulation of enzyme synthesis by its substrate.

Remember, glucose or galactose cannot act as inducers for lac operon. Can you think for how long the lac operon would be expressed in the presence of lactose?

Regulation of *lac* operon by repressor is referred to as **negative regulation**. *Lac* operon is under control of positive regulation as well, but it is beyond the scope of discussion at this level.

Lactose is the substrate for the enzyme beta-galactosidase and it regulates switching on and off of the operon. Hence, it is termed as **inducer**. In the absence of a preferred carbon source such as glucose, if lactose is provided in the growth medium of the bacteria, the lactose is transported into the cells through the action of permease (Remember, a very low level of expression of *lac* operon has to be present in the cell all the time, otherwise lactose cannot enter the cells). The lactose then induces the operon in the following manner.

DOPA

Q1 In E.coli main control of Gene Expression
(a) Transcription (b) Translation (c) transport (d) all

Q2 lactose metabolism Enzyme in E.coli is
(a) control By common promotor (b) Always Express (c) constitutive (d) all

Q3 constitutive Gene is
(a) lac i (b) lac z (c) lac y (d) lac a

Q4 lac operon is switch on when
(a) lactose present Glucose present (c) lactose Abrent Glucose present (c) Glucose Abrent lactose present (d) all

Q5 B-Galactosidase is
(a) Part of operon control (b) Part of polycistronic Arrangement (c) Structural Gene (d) all

Q6 In lac operon, when lac i gene Express, No lactose in medium (which is correct)
(a) Repressor not Bind on operator (b) RNA polymerase Bind on operator (c) One structural gene Express (a) Negative Regulation occur

Q7 lac operon is inducible operon because

(a) In General structural Gene not Express (b) In General structural Gene Express (c) In General structural gene off can be Express By inducer (d) all

Q8 In lac operon inducer is

(a) lactose (b) Allolactose (c) Substrate (d) all

Q9 Induce in lac operon

(a) Activate Regulater gene (b) Regulate Regulater & structural Gene (c) Inactivate Repressor protein (d) Activate Repressor protein

Q10 Small level of lac operon Expression is present

(a) some time (b) Always For lactose Hydrolysis (c) Always For lactose Entry (d) all

Q11 Mutation in lac i gene

(a) Operon Always close (b) Repressor not Form (c) Inactive Repressor (d) all

Q12 RNA polymerase not Bind on promoter when –

(a) lac i inactive (b) lac i active (c) Repressor not Active (d) lactose present

Molecular Basis of inheritance

Nucleic Acid

DNA – Genetic material – all living cell + Some virus

RNA – Genetic material – Some virus

Adapter – tRNA Catalyst – rRNA

ΦX174 – 5382 – SS DNA

λ – phage – 48502 BP – dsDNA

E. coli – 4.6×10^6 BP

Human – 3.3×10^9 BP (haploid)

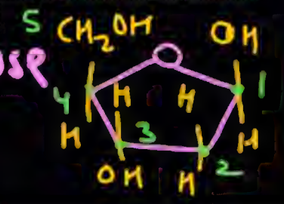
structure

Phosphodiester

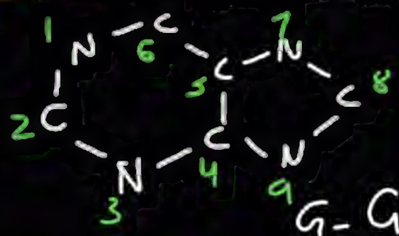
Polynucleotide Chain → nucleotide

Sugar – Ribose (5C, Furan) (2'-OH)

Deoxyribose (2'-H)



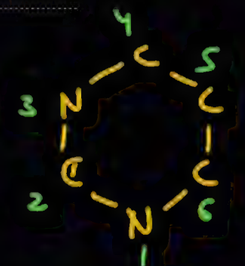
Nitrogenous Base → Purine – 9 member – Double Ring



A-Adenine

G-Guanine

Pyrimidine – 6-Member – Single Ring



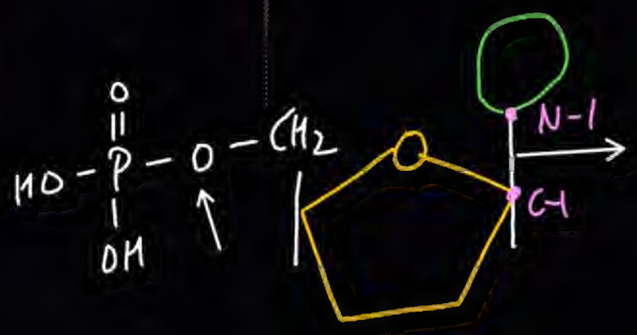
C ← U → T

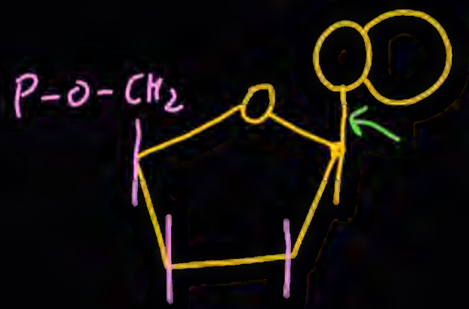
Cytosine

Uracil (2,4 Dioxo Pyrimidine)

Thymine (5-methyl uracil)

Sugar	N·B	Nucleoside	nucleotide
Ribose	A		
Ribose	U		
Ribose	C		
Ribose	G		
Deoxyribose			





Discovery of DNA

1869 - Meischer → Nuclein (limitation - Isolation of DNA in intact Form

Wilkins & Franklin - X-ray Diffraction

Chargaff's rule → $\frac{A+G}{T+C}=1$ $\frac{A}{T}=\frac{G}{C}=1$

DNA Double helix model → Watson & Crick - 1953 → Hallmark - Complimentary Base pairing → Explain - DNA Replication - Sequence of other strand can be predicted

(a) DNA → two polynucleotide chain (S-P → Backbone)

(b) Direction - 5'–3' 3'–5' (N.B inside

(c) Purine Bp with Pyrimidine (Doble ring & Single ring) (A & T - two H-Bond, G & C - three H-Bond)

(c) Right Handed coil – 1 turn 10 Bp

Pitch = 3.4 nm Distance B/w two Bp = 0.34 nm

(e) H-Bond Stacking of Bp (Extra stability)

Central dogma (Crick) → DNA ⟲ (Replication) → DNA —Transcription→ mRNA —Translation→ Protein

Flow of information, Some virus (RNA to DNA) (Reverse transcriptase Reverse transcription (Retro virus)

Packaging of DNA

E. coli → 4.6×10^6 Bp × 0.34 nm = 1.36 mm

→ DNA is package - Basic protein

- Circular DNA, Form large loops with protein (Nucleoid)

Eukaryotes → Human → haploid - 3.3×10^9 Bp (1.1 m)

→ Diploid - 6.6×10^9 Bp (2.2 m)

- 2.2 meter in 10^{-6} m nucleus

- Histone help in packaging

Histone - Rich in lysine & Arginine (Side chain Extra NH_2) — octamer H_2A, H_2B, H_3, H_4

Octamer + DNA → Nucleosome (DNA - 200 Bp H_1 – Sealing)

Beads on string – EM – DNA + nucleosome

NHCs – Higher level packaging

→ $G_1 + S + G_2$ – Chromatin most condense – M-phase

Euchromatin - less condense, light stain

Transcriptionally Active

Heterochromatin – more condense

transcriptionally inactive

Search of Genetic material - Quest to determine genetic material - 1926

Transformation - Bacteria - Pneumonococcus

→ R-strain - non-virulent
→ S-strain - Virulent → Smooth/shiny colony (mucus coat)

Griffith - 1928

R-strain → mice → mice Alive
S-strain - Mice killed
Heat Killed S-strain - Mice alive
R strain + Heat killed S-Strain → Mice killed

Some Tranforming principle - From Heat Killed S - transform R into S (Change into physical Form
↓
(Unknown)

Avery McCarty Macleod - Purified Biochemical

(Prior to work - Protein thought to be Genetic material

(From S-strain
→ RNAse + DNAse → No transformation
→ Protease + DNAse → No transformation
→ Protease + RNAse → Tranformation occur

In presence of DNAse
No Tranformation

Harshey and chase - 1952

Bacteriophage → Genetic material Enter
Lysis occur

S^{35} - Radioactive protein
P^{32} - Radioactive DNA

Virus with S^{35} - Radioactivity - Supernatant
Virus with P^{32} - Pellet Radioactive

Three step - Infection - Genetic material Enter
Blending - cover Removed
Centrifugation - Pellet - E.coli + Virus Genetic material
Supernatant - Virus cover

why DNA is Genetic material

Good Genetic material
(a) Structurally & Chemically stable
(b) Able to make Replica
(c) Slow mutation
(d) Express mendelian pattern

- RNA - Single strand - less stable, Can Act as catalyst, 2'-OH make it labile, Uracil most Reactive
  DNA - Double strand. more stable, 2'-H, thymine → Never Act as catalyst
- DNA & RNA - Both can make copy
- RNA - mutate Faster (RNA virus)
- RNA Express through protein

[ØB bacteriophage + TMV - RNA genetic material

Storage of Genetic information - DNA
Expression - RNA

RNA world – First Genetic material RNA (Splicing, Catalyst) But Unstable
– 2'-OH change to 2'-H & Uracil to thymin ⟶ Single strand to double strand

DNA Replication ⟶ Semi-conservative – one old, one new strand [Watson & Crick – Predicted possible mode of DNA Replication]

semi conservative – 1958 (First – E. coli → Plant → Human) – Plant – Vicia Faba
Messelson & Stahl – E. coli (N^{14} & N^{15} → Heavy isotop
Radioactive thymidine – Taylor – 1958
(Semi conservative in DNA & Chromosome

E. coli ⟶ on N^{15} source (Both strand N^{15}) ⟶ (NH_4Cl, N_{14} source, 20 min) ⟶ Ist Generation 100% Hybrid ⟶ IInd (40 min) 50% Hybrid, 50% light ⟶ 3rd generation (60 min) 25% Hybrid

Detail of DNA Replication

– Prokaryotes – Prior to Fission, Cytoplasm
Faster than Eukaryotes (2000 Bp/sec)
(Semiconservative ↓)
– Eukaryotes – S-phase, Nucleus

R = Replicon → independent Evented DNA Replication
Origin – DNA Replication start – centre of Replicon – origin

At origin – Two Replication Forks

Main Enzyme – DNA polymerase – Direction – 5'–3'
Require primer
Template →
Other name – DNA Dependent DNA polymerase
Substrate – deoxy ribose nucleoside triphosphate
(Dual Role – (i) Substrate
(ii) Energy

Steps in DNA Replication

Helicase – Open DNA

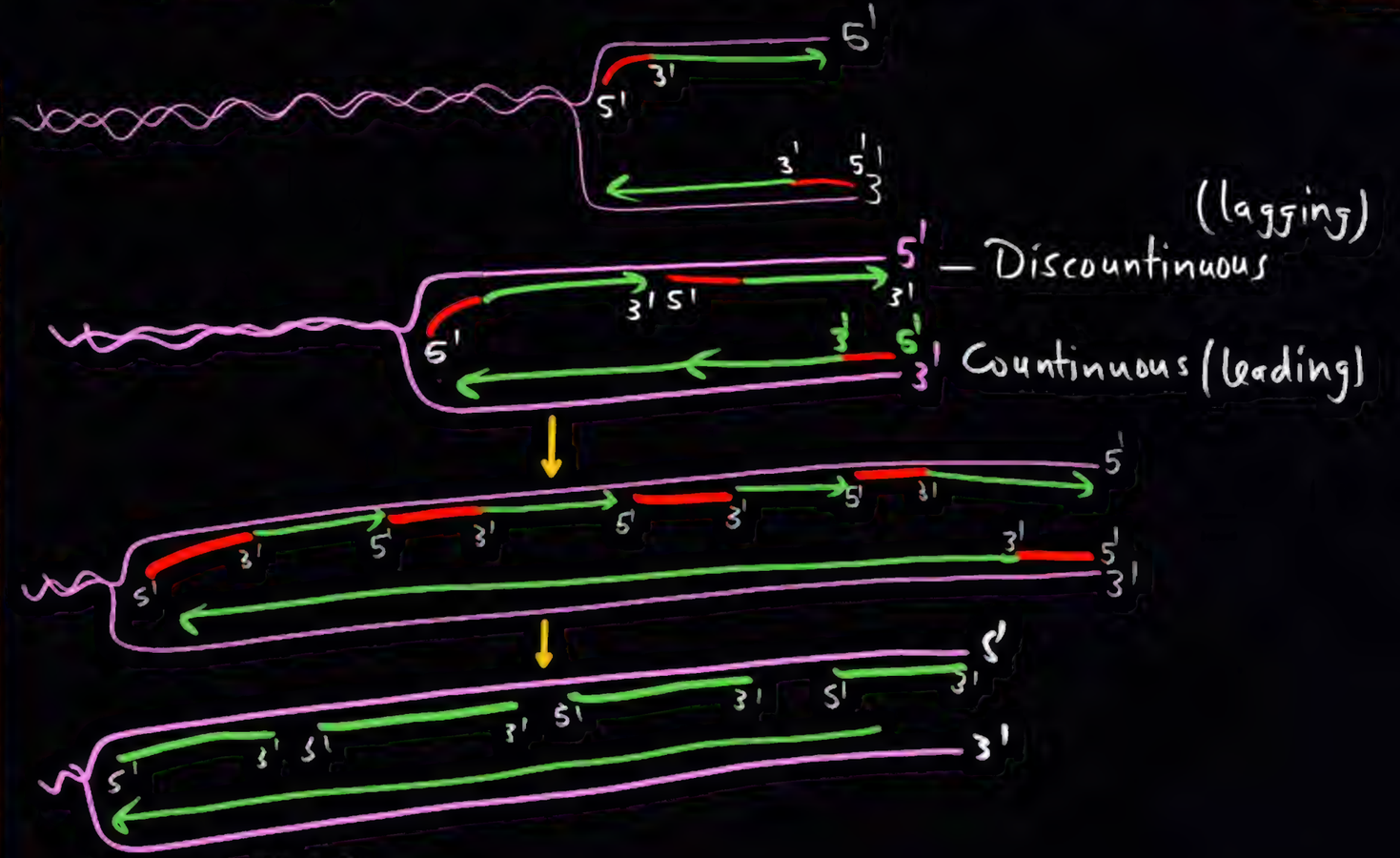
Primase – Primer of RNA

SSB – Keep DNA open

Topoisomerase – dec. –ve supercoiling

DNA polymerase
- Add one nucleotide at 3' end
- So DNA synthesis in 5'–3' Direction

Complete DNA not open at once →



Gap is Filled By

Gap is sealed By

Transcription

- Copying information of DNA into RNA
- RNA is copy → not same But Similar

Location – Cytoplasm (Prokaryotes
Nucleus (Eukaryotes
– all DNA not transcribe

$G_1 + S + G_2$ – Phase – Transcription

Both strand not Act as template
(a) if same time occur – ds RNA Form
(b) If Different time occur – two different protein

steps in transcription

Initiation – RNA polymerase + Sigma Factor
(Recognise Promoter → Small piece of RNA Form

Elongation – Sigma Factor leave
RNA polymerase Act

Termination – RNA polymerase + Rho factor
Recognise terminator Region → RNA leave First
Enzyme leave ← DNA close

Prokaryotes – Cytoplasm, Coupled transcription & translation
Single RNA pol

Eukaryotes → Nucleus, three RNA polymerase

Transcription unit

Independent
Event of transcription
T.U – 1 Gene – monocistronic
T.U – Many Gene – Polycistronic

- P – Promoter – transcription start
attach 5'-end upstream – coding strand
T – Terminator – 3'-end downstream – coding strand

Structural Gene – S.G –
- Template – Actually Function
- Coding – code similar to RNA (U in place of T)

Definition – Gene – Unit of inheritance
Difficult to define in Sequence

– Gene – code For Any type of RNA
– Cistron those gene code For polypeptide

Prokaryotes → 1 transcription unit – many cistron
Eukaryotes – 1 Transcription unit – Single cistron

Eukaryotes – Split gene – Gene give coding Exon
non-coding intron

↓
Reminiscent of Antiquity

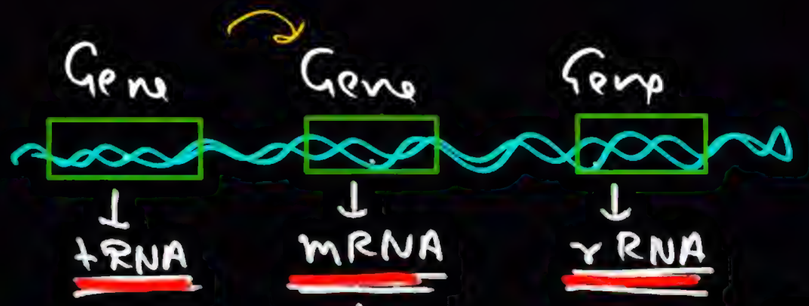
(Transcription Unit & Gene)

Gene → Segment code For Any type of RNA

Cistron – Segment → code For polypeptide
(all cistron Gene But Genes are not
Prokaryotes = 1 Transcription – Many cistron
Unit (Polycistronic)

Eukaryote = 1 TU = 1 Cistron
(Monocistronic)

Eukaryotes Split Gene – Previously
Archaebacteria
hRNA
Intron
mRNA
not in
Eubacteria
Eukaryotes



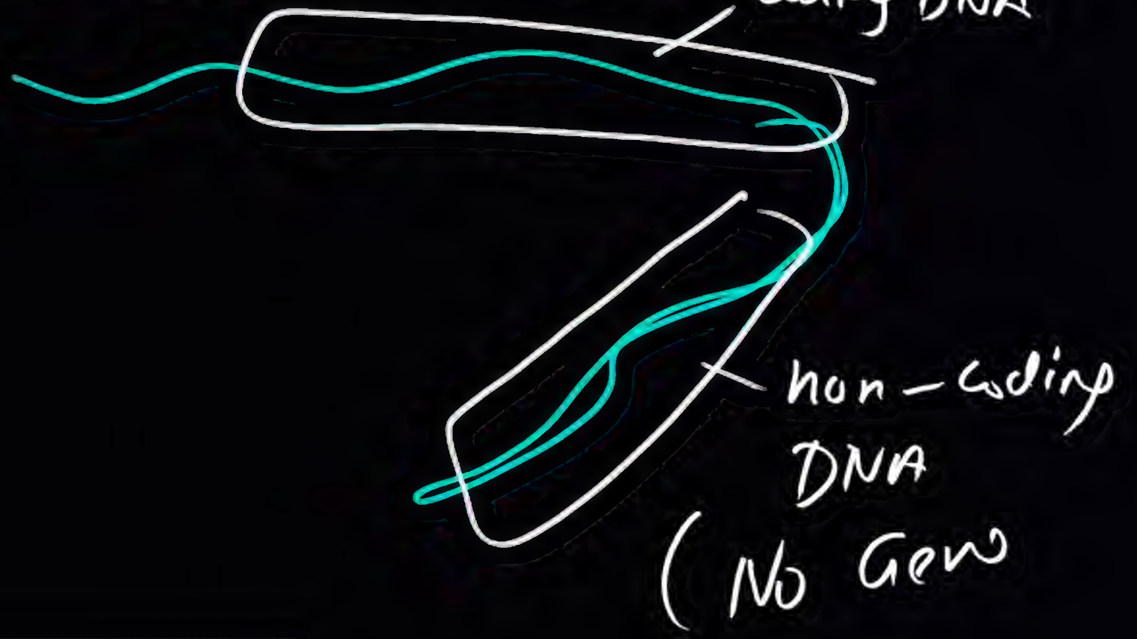
Polypeptide

Eukaryotes
P Cistron T
hnRNA
mRNA → Polypeptide
(Monocistronic)

Prokaryotes
P T
Cistron Cistron Cistron
mRNA
mRNA
mRNA
Poly
Polypeptide
Polypeptide
(Polycistronic)

Gene → tRNA
→ rRNA
→ T.U = Gene (split Gene) (Eukaryote)
→ Many Gene = T.U
→ Regulatory sequen = Gene
→ Regulator Gene

Regulatory Gene
Gene
Cistron = 3
P
T
mRNA
Regulator protein
Regulatory sequence = operator
tRNA
rRNA
(not Form RNA



cell theory

Type of RNA

23 sr RNA

- r RNA – ribosomal RNA → Catalyst (Ribozyme) + Structural (most stable Abundant)
- t-RNA – transfer RNA, Soluble RNA, Read code on mRNA, Bring A.A on Ribosome
- hnRNA → modify into mRNA
- Sn RNA → Small nuclear RNA (splicing)
- Sc RNA – Small cytoplasmic RNA (SRP)

Transfer RNA – Soluble, Adapter

Crick – Adapter hypothesis – Amino Acid can not Read code, Some Adapter present

t-RNA Discovered → Genetic code → Role of t-RNA

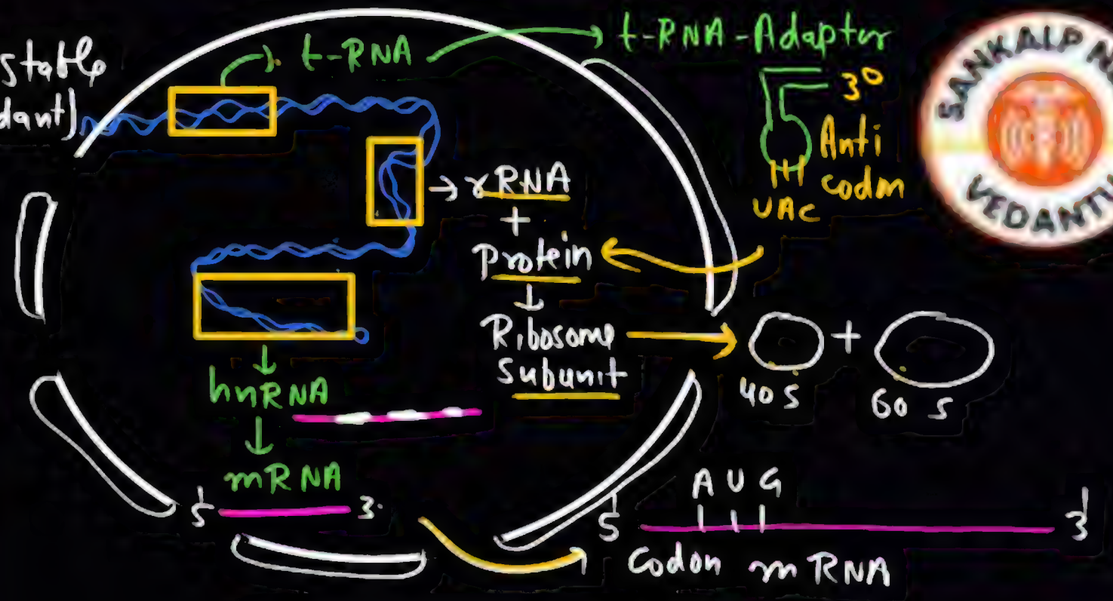
1° → 2° → 3' → A.A Acceptor Arm → 3° (Functional) inverted L-shape

Clover leaf

Anticodon Arm

- no t-RNA For stop codon ✓
- Functional is – inverted L-shape
- Different initiator codon

Prokaryotes		Eukaryotes	
RNA polymerase	r RNA	RNA pol I – r	28 S, 5.8, 18 S
	t RNA	RNA Pol II – h	
	mRNA	RNA Pol III – t	5 S r RNA



Ribosomal RNA (r RNA)

80 S → 60 S → 28 S, 5.8 S, 5 S] 80 type protein
80 S → 40 S → 18 S (nucleolus)]

70 S → 50 S → 23 S, 5 S
70 S → 30 S → 16 S

Post transcriptional modification

hnRNA (less stable) → PTM → mRNA

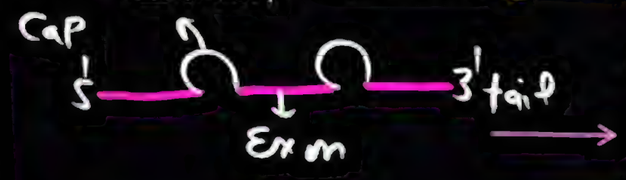
Capping — m⁷G 5′ (7-methyl Guanosine tri phosphate)

tailing — AAA 3′ (200–300 polyAdenylate)

Intron — not come in processed RNA

Exon — come in processed RNA

splicing [Removal of intron & Linking of Exon



→ 5′ — mRNA — 3′ (smaller than hnRNA) (Use in Reverse transcription)

Stability → rRNA > tRNA > mRNA > hnRNA

Amount → rRNA > tRNA > mRNA

Smallest — tRNA

Genetic code

DNA Replication, transcription — Complimentary Base pairing

Translation — no such Relation

deciphering — How much nucleotide — 1 A·A which set of nucleotide For which A·A

(organic chemist, Biochemist, Geneticist, physicist

Meth — AUG

Trp — UGG

UUU — Phe

George Gamow — Genetic code triplet

4^1 = 4 code 4^2 = 16 code 4^3 = 64 code

UAA, UGA, UAG — stop codon

Severo ochoa — Polynucleotide phosphorylase

Nirenberg — Cell Free Synthesis of protein (deciphering)

H. G Khorana

Salient Feature

(a) Triplet ✓

(b) AUG — start codon — Dual Role (start & mid)

UGA, UAG, UAA } stop codon

(c) Without punctuation ✓

(d) nearly Universal (Except — some protozoa, Mitochondria ✓

(e) degenerate

Glycine → GGG, GGC

If Unambiguous → GGG → Glycine

GGG ✗ → Leucin

Mutation → substitution (SCA) — one A·A change

Deletion & Addition — FRAME Shift

RAM HAS RED CAP

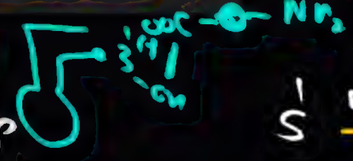
Translation – location - Cytoplasm

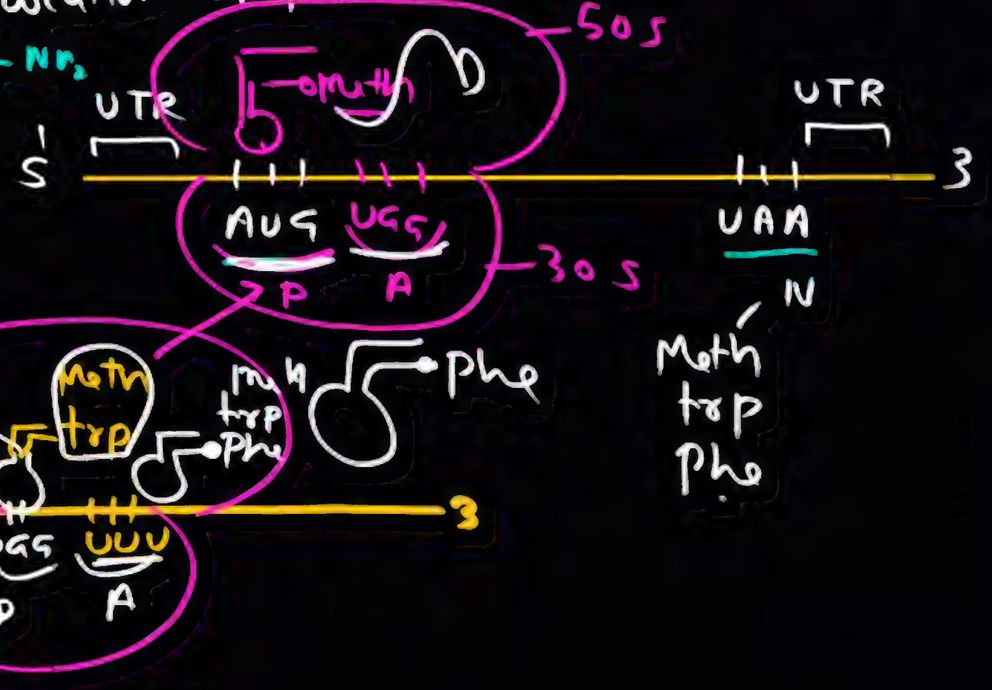
[Charging of t-RNA

Amino Acid + ATP → Amino AcylPAMP

Amino Acyl AMP + t RNA → Charge t-RNA + AMP

Enzyme – Amino Acyl t-RNA synthetase



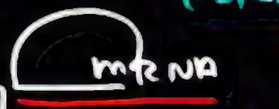


Steps

(a) mRNA + Small Subunit

(b) Charge t-RNA at P-site

(c) large Subunit



(d) Charge t-RNA at - A site ✓ 23S

(e) Peptide Bond Form ✓ (Peptidyl transferase)

(f) t-RNA Empt at P-site move out

(g) Ribosome move Forward

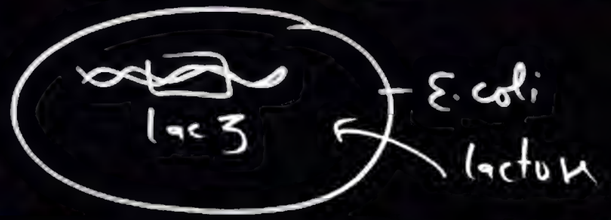
(h) Stop codon at A-site

no t-RNA → Release Factor At

Regulation of Gene Expression

Need - Metabolic, Development, Environment, Physiologies

Levels → Transcription
PTM
Prokaryotes – Transport
– Translation
] Eukaryotes



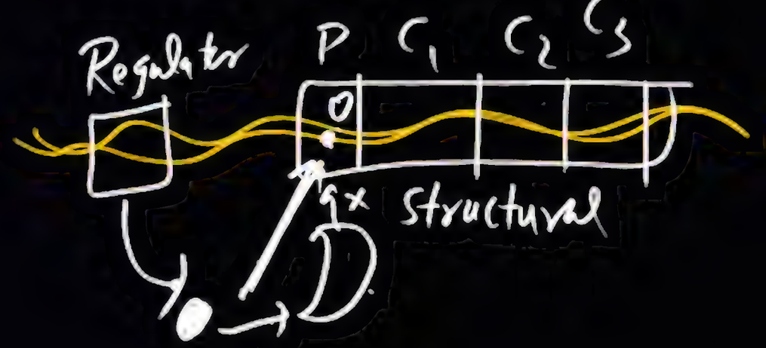
(tRNA, rRNA, mRNA)

Always

Constitutive → Express
non-constitutive → control

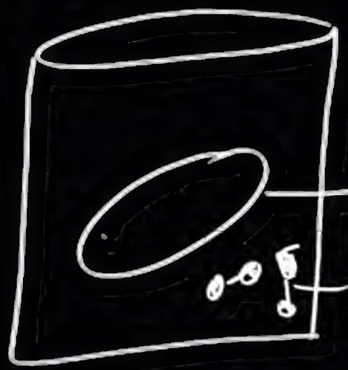
Type of Gene — Structural — Enzymes
Regulator → Regulator → protein
Stop (-ve)
Promoter (+ve)

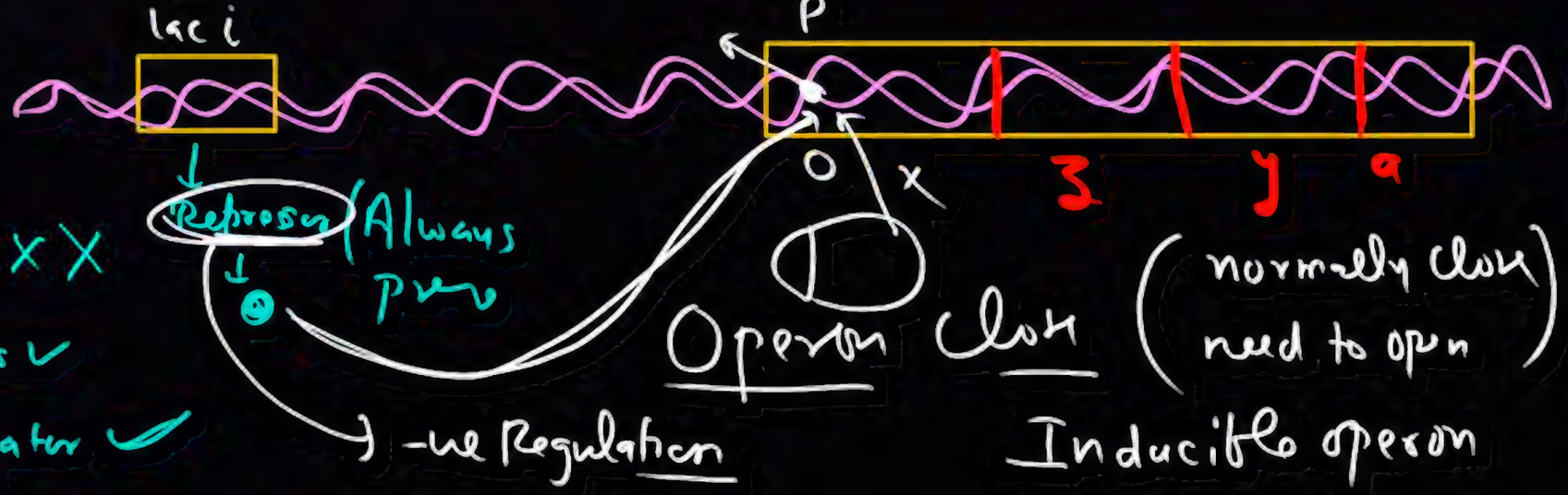
Concept of Operon



Glu - Gular

1 galactosidase ✓ (lactose (Glycosidic)
2 Permease ✓ → channel
3 transacetylase ✓





Case - I

lactose X X

↓

Repress ✓

↓

Bind on Operator ✓

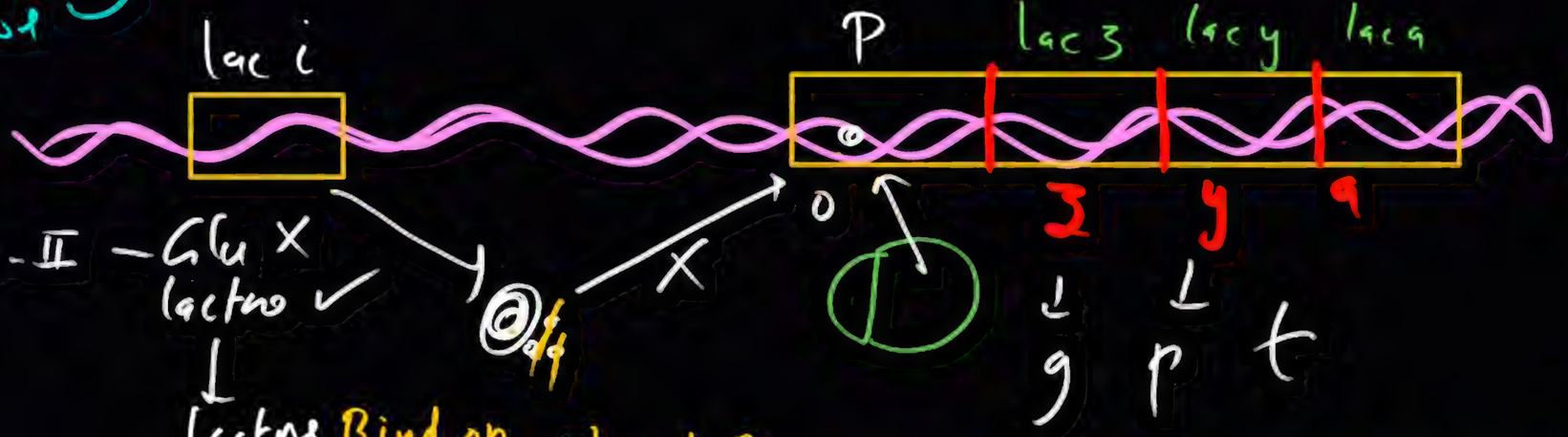
↓

Prevent transcription

↓

Stop RNA pol

Z	
Y	
a	



Case - II - Glu X lactose ✓

↓

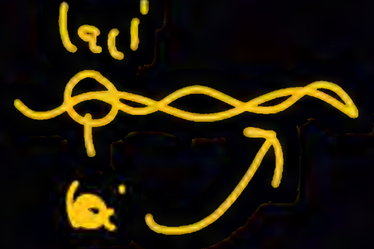
lactose Bind on Repressor → not Bind on operator → RNA Polymerase transcription

g p t

Transcription

Promote = lactose (Inducer)

DOPA



Q1 In E.coli main control of Gene Expression
(a) Transcription (b) Translation (c) transport (d) all

Q2 lactose metabolism Enzyme in E.coli is
(a) control By common promoter (b) Always Express (c) constitutive (d) all

Q3 constitutive Gene is (Regulator Gene)
(a) lac i (b) lac z (c) lac y (d) lac a

Q4 lac operon is Switch on when
(a) lactose present Glucose present (c) lactose Abrent Glucose present (d) Glucose Abrent lactose present (all)

Q5 B-Galactosidase is
(a) Part of operon control (b) Part of polycistronic Arrangement (c) Structural Gene (d) all

Q6 In lac operon, when lac i gene Express, No lactose in medium (which is correct)
(a) Repressor not Bind on operator (b) RNA polymerase Bind on operator (c) One structural gene Express (d) Negative Regulation occur

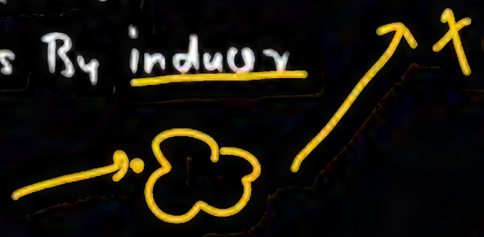
Q7 lac operon is inducible operon because

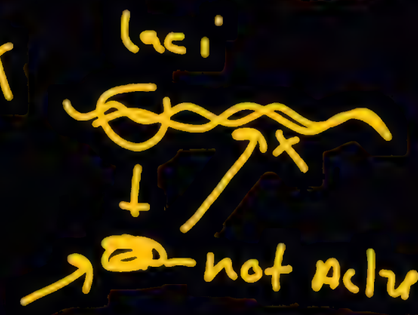
(a) In General structural Gene not Express

(b) In General structural Gene Express ✗

(c) In General structural gene off can be Express By inducer

(d) all





Q8 In lac operon inducer is

(a) lactose (b) Allolactose (c) Substrate (d) all

Q9 Inducer in lac operon

(a) Activate Regulator gene (b) Regulate Regulator + structural Gene (c) Inactivate Repressor protein (d) Activate Repressor protein

Q10 Small level of lac operon Expression is present

(a) Some time (b) Always For lactose Hydrolysis (c) Always For lactose Entry (d) all

Q11 Mutation in lac i gene

(a) Operon Always close ✗ (b) Repressor not Form (c) Inactive Repressor (d) all both b & c

Q12 RNA polymerase not Bind on promoter when –

(a) lac i inactive (b) lac i active (c) Repressor not Active (d) lactose present

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SANKALP NEET VEDANTU

Organism and population

lecture-01

Botany

TARUN SIR

Organism and population

Abiotic Factor

effect of Abiotic factor

Adaptation

Population Attribute

Population Growth

Population Growth model

Population interaction

Ecology → 3 chapter → 60

Basic introduction

- complexity present at all level of organization → cell, tissue, organ, organism (Complex)
- At All levels we try to Answer → 'How' and Why

Biome ← Community ← Population

Ex- Bird Singing → 'How' → which process, which Mechanism (Vocal cord + Bone → Voice produce)

Why → Attract bird For mating

Our living world is fascinatingly diverse and amazingly complex. We can try to understand its complexity by investigating processes at various levels of biological organisation–macromolecules, cells, tissues, organs, individual organisms, population, communities, ecosystems and biomes. At any level of biological organisation we can ask two types of questions – for example, when we hear the bulbul singing early morning in the garden, we may ask – 'How does the bird sing?' Or, 'Why does the bird sing ?' The 'how-type' questions seek the *mechanism* behind the process while the 'why-type' questions seek the *significance* of the process. For the first question in our example, the answer might be in terms of the operation of the voice box and the vibrating bone in the bird, whereas for the second question the answer may lie in the bird's need to communicate with its mate during breeding season. When you observe nature around you with a scientific frame of mind you will certainly come up with many interesting questions of both types - *Why are night-blooming flowers generally white? How does the bee know which flower has nectar? Why does cactus have so many thorns? How does the chick spures recognise her own mother?* and so on.

Biological organization level

Macromolecule
↓
Cell
↓
tissue
↓
organ
↓
organism
↓
Population
↓
Communities
↓
Ecosystem
↓
Biome →

Q which is largest Unit in Ecology
(1) Organism
(2) Community
(3) Ecosystem
(4) Biome

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What is Ecology

def - It is study of interaction of Among (Biotic (Food chain)
and Abiotic with Biotic and Abiotic & Abiotic (Ex - Soil Formation)
(Ex - Photosynthesis

Biotic (Plant) ⟷ Biotic (Animal)
↕
Abiotic ⟷ Abiotic

levels of Ecology – Smallest level of Ecology – Organism level

- **Organism** → Adaptation, Migration, Suspension } organism Behaviour } Physiological Ecology
- **Population** – Member of same species, Common geography } → Birth rate, death Rate, Population density
- **Community** → Group of Different population (Food chain, Food web
- **Biome** → Area – with Annual Average temp, Annual Average precipitation (Rainfall)
  Specific vegetation
  Ex- Desert Biome, tropical Forest

(1) Soil Formation is interaction of
(a) Air & water with soil ✓
(b) Help of lichen ✓
(c) decomposition By
Microbes ✓
~~(d)~~ all

You have already learnt in previous classes that Ecology is a subject which studies the interactions among organisms and between the organism and its physical (abiotic) environment.

Ecology is basically concerned with four levels of biological organisation – organisms, populations, communities and biomes. In this chapter we explore ecology at population levels.

Population

definition – Group of organism of same species, living in a common Geography which can share or compete For Resources and which can interbreed

Acc. to this → only Product of Sexual Reproduction is counted in population (This is true only According to genetics)

But Acc. to Ecology → Product of Asexual Reproduction is also counted in population

Ex – teak tree
- → Rat in Abondoned dwelling ✓
- – Cormorants (Bird) in wet land ✓
- – Lotus in Pond ✓
- → Rose By stem cutting ✓

– Bacteria in culture plate

[Q which is population Acc. to Both Ecologist & Geneticist]

(a) Rat population ✓
(b) Plant From seed of pea ✓
(c) Algae Population From Zoospore (Asexual
(d) Both a & b

Importance of population Ecology →
(a) It is organism which show Adaptation, But natural selection Act on population

11.1 Populations

11.1.1 Population Attributes

In nature, we rarely find isolated single individuals of any species; majority of them live in groups in a well defined geographical area, share or compete for similar resources, potentially interbreed and thus constitute a population. Although the term interbreeding implies sexual reproduction, a group of individuals resulting from even asexual reproduction is also generally considered a population for the purpose of ecological studies. All the cormorants in a wetland, rats in an abandoned dwelling, teakwood trees in a forest tract, bacteria in a culture plate and lotus plants in a pond, are some examples of a population. In earlier chapters you have learnt that although an individual organism is the one that has to cope with a changed environment, it is at the population level that natural selection operates to evolve the desired traits. Population ecology is, therefore, an important area because it links ecology to population genetics and evolution.

Attributes to Describe population (Some parameter About Population)

I **Birth rate** – Single individual Birth & Death But For population Birth rate or Death rate present

↳ def – It is number of Birth per capita (per 100, per thousand) in Given time

Q In a pond → 20 lotus ⟶ 24 lotus (After one Year)

Birth rate = $\frac{\text{Change}}{\text{initial}} = \frac{24-20}{20} = \frac{4}{20} = 0.2$ individual | lotus | year

– Sunflower → 40 After Increase of 4 Flower in one month

Initial = 36 Final = 40 Birth rate = $\frac{4}{36} = 0.11$ individual | sunflower | month

2. **Death Rate**

It is no. of death per capita | unit time

Q laboratory → 40 Fruitfly, 4 death → 1 week

death rate = $\frac{4}{40} = 0.1$ individual / Fruitfly / week

Q In a population of Cormorants (Bird) in wetland → Change From 200 to 150 in a month death rate

Change = 50
initial = 200
$\longrightarrow \frac{50}{200} \Rightarrow 0.25$ individual | Cormorant | month

3. **Sex Ratio** – It is Ratio of male & Female in population

India → Sex Ratio → 936 (meaning – 936 Female / 1000 male)

Significance → population Growth predict

4. **Age distribution** – In a population, Different Age Group → Percentage present

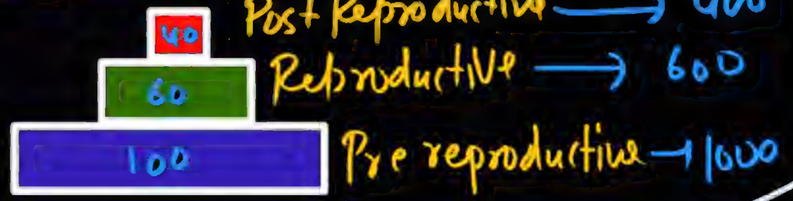
According to which → How population is Increasing or decreasing

0–15 yr – Pre Reproductive
15–45 – Reproductive
45+ → Post Reproductive

} – Age distribute Acc. to Reproduction capacity

Type of Population

Expanding

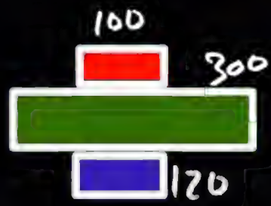


- Pre R > R > Post R
- Shape not change But Size Inc.
→ developing countries

Stabilizing

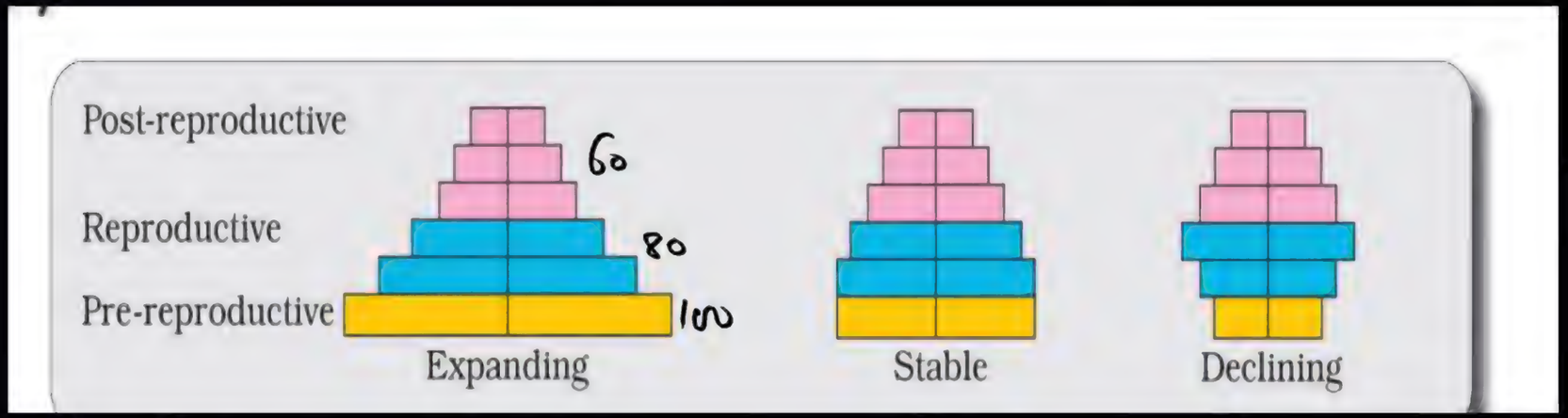
- Pre R = R > Post Rep
- developed countries
- No Change in shape & Size
- Spindle shape

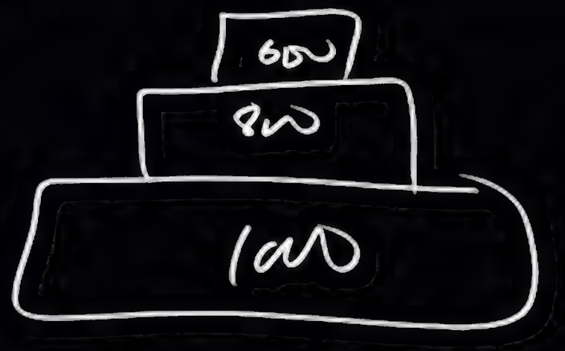
Declining (Urn shape)

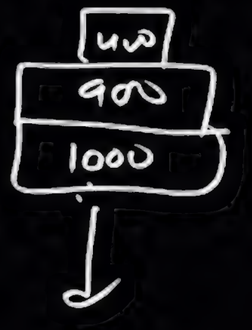


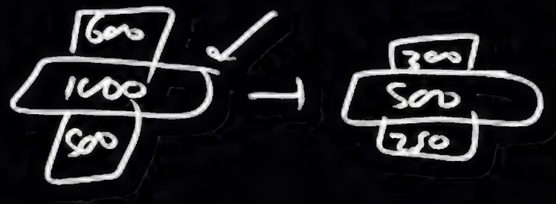
Reproductive > Pre R = Post R

- Highly developed Countries
- Graph – Cost of living High


Post-reproductive
Reproductive
Pre-reproductive
60
80
100
Expanding
Stable
Declining


600
800
1000


400
900
1000


600
1000
500
300
500
250

⑤ Population size

Size of population depend on → competition, predation, insecticide Application

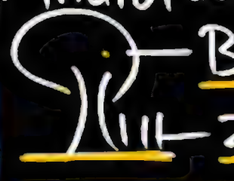
(Size of population → as low → Summer Siberian Crane – less than 10

High → Millions Chlamydomonas in pond

Population density (N) → also known as population → Best method to count number / Area

Best method – counting number of individual

other method → ① Area cover or Biomass



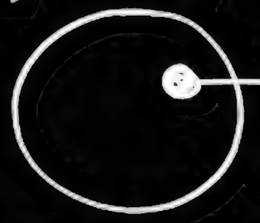
Banyan tree – 1

200 paratherium

not good to count number

② Counting colonies – Petriplate of Bacteria culture

(For this colonies count)



Colony (Difficult to count number

③ Relative density – Single catch number of Fish in pond multiple Area

→ not Absolute density it is Relative Density

④ Indivect Method → tiger censys → Pug marks & Faecal pellet

The size of the population tells us a lot about its status in the habitat. Whatever ecological processes we wish to investigate in a population, be it the outcome of competition with another species, the impact of a predator or the effect of a pesticide application, we always evaluate them in terms of any change in the population size. The size, in nature, could be as low as <10 (Siberian cranes at Bharatpur wetlands in any year) or go into millions (*Chlamydomonas* in a pond). Population size, technically called **population density** (designated as N), need not necessarily be measured in numbers only. Although total number is generally the most appropriate measure of population density, it is in some cases either meaningless or difficult to determine. In an area, if there are 200 carrot grass (*Parthenium hysterophorus*) plants but only a single huge banyan tree with a large canopy, stating that the population density of banyan is low relative to that of carrot grass amounts to underestimating the enormous role of the Banyan in that community. In such cases, the per

grass (*Parthenium hysterophorus*) plants but only a single huge banyan tree with a large canopy, stating that the population density of banyan is low relative to that of carrot grass amounts to underestimating the enormous role of the Banyan in that community. In such cases, the per cent cover or biomass is a more meaningful measure of the population size. Total number is again not an easily adoptable measure if the population is huge and counting is impossible or very time-consuming. *If you have a dense laboratory culture of bacteria in a petri dish what is the best measure to report its density?* Sometimes, for certain ecological investigations, there is no need to know the absolute population densities; relative densities serve the purpose equally well. For instance, the number of fish caught per trap is good enough measure of its total population density in the lake. We are mostly obliged to estimate population sizes indirectly, without actually counting them or seeing them. The tiger census in our national parks and tiger reserves is often based on pug marks and fecal pellets.

Population Growth

- Population size is not static parameter (gt change with — Adverse weather, Competition, Predation pressure)

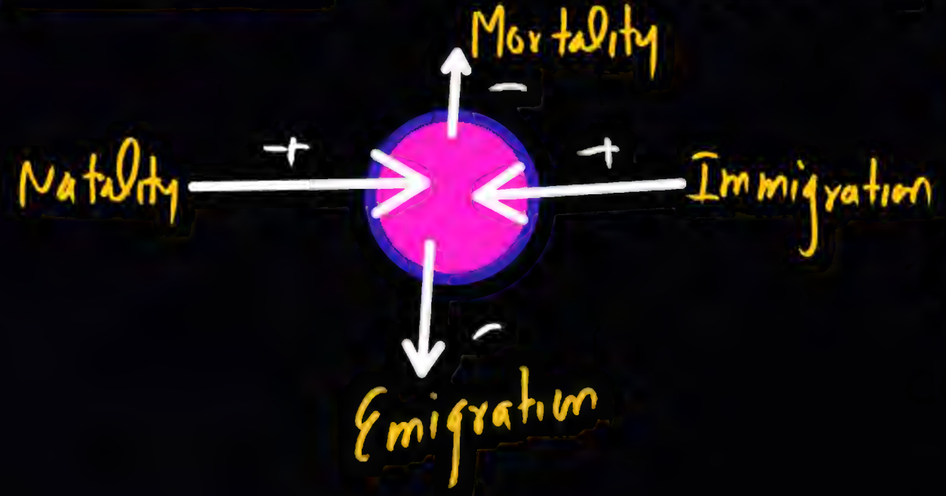
→ Population density change with Four Basic process

(B)
(1) Natality - gt is number of Birth in a population of same species

(D)
(2) Mortality - gt is number of Death in a population of same species

(3) Imigration (I) → Member of same species, Enter into population (Enter into geography)

(4) Emmigration → Member of same species, move out From population



N_0 = Initial population Density N_T = Final population density

$$N_T = N_0 + (B+I) - (D+E)$$

$$= N_0 + (B-D) + (I-E)$$

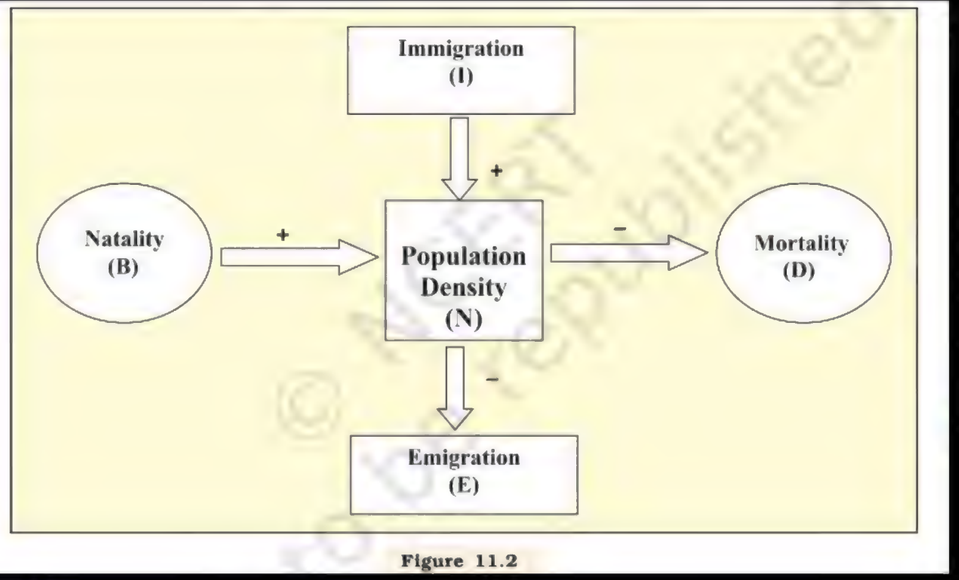


Figure 11.2

$$N_T = N_0 + (B - D) + (I - E)$$

- normal population → change in population density is due to Difference in Birth and death
- In special case → Newly colonise city
  Difference in Immigration & Emmigration
  Responsible For population Growth

11.1.2 Population Growth

The size of a population for any species is not a static parameter. It keeps changing with time, depending on various factors including food availability, predation pressure and adverse weather. In fact, it is these changes in population density that give us some idea of what is happening to the population – whether it is flourishing or declining. Whatever might be the ultimate reasons, the density of a population in a given habitat during a given period, fluctuates due to changes in four basic processes,

cell theory

two of which (natality and immigration) contribute to an increase in population density and two (mortality and emigration) to a decrease.

(i) ***Natality*** refers to the number of births during a given period in the population that are added to the initial density.

(ii) ***Mortality*** is the number of deaths in the population during a given period.

(iii) ***Immigration*** is the number of individuals of the same species that have come into the habitat from elsewhere during the time period under consideration.

(iv) ***Emigration*** is the number of individuals of the population who left the habitat and gone elsewhere during the time period under consideration.

cell theory

Molecular Basis of inheritance

Nucleic Acid

DNA – Genetic material – all living cell + Some virus

RNA – Genetic material – Some virus

Adapter – tRNA Catalyst – rRNA

ΦX174 – 5382 – SS DNA

λ – phage – 48502 BP – dsDNA

E. coli – 4.6×10^6 BP

Human – 3.3×10^9 BP (haploid)

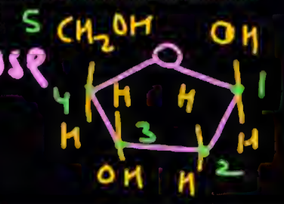
structure

Phosphodiester

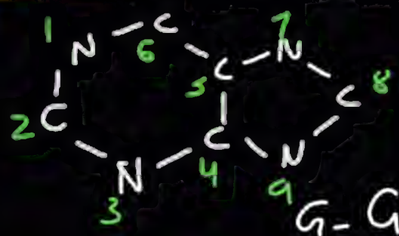
Polynucleotide Chain → nucleotide

Sugar – Ribose (5C, Furan) (2'-OH)

Deoxyribose (2'-H)



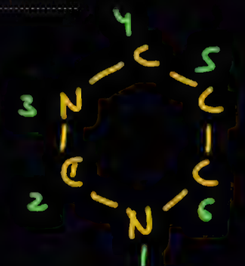
Nitrogenous Base → Purine – 9 member – Double Ring



A-Adenine

G-Guanine

Pyrimidine – 6-Member – Single Ring



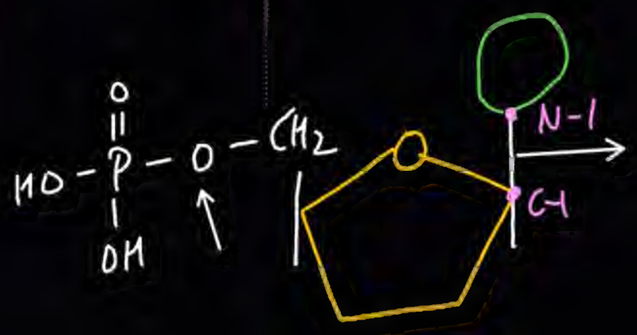
C ← U → T

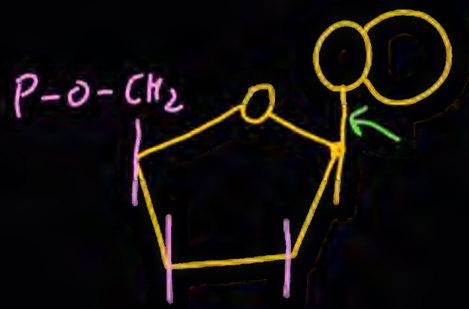
Cytosine

Uracil (2,4 Dioxo Pyrimidine)

Thymine (5-methyl uracil)

Sugar	N·B	Nucleoside	nucleotide
Ribose	A		
Ribose	U		
Ribose	C		
Ribose	G		
Deoxyribose			





Discovery of DNA

1869 - Meischer → Nuclein (limitation - Isolation of DNA in intact Form

Wilkins & Franklin - X-ray Diffraction

Chargaff's rule → $\frac{A+G}{T+C}=1$ $\frac{A}{T}=\frac{G}{C}=1$

DNA Double helix model → Watson & Crick - 1953 → Hallmark - Complimentary Base pairing → Explain - DNA Replication - Sequence of other strand can be predicted

(a) DNA → two polynucleotide chain (S-P → Backbone)

(b) Direction - 5'–3' 3'–5' (N.B inside

(c) Purine Bp with Pyrimidine (Doble ring & Single ring) (A & T - two H-Bond, G & C - three H-Bond)

(c) Right Handed coil – 1 turn 10 Bp

Pitch = 3.4 nm Distance B/w two Bp = 0.34 nm

(e) H-Bond Stacking of Bp (Extra stability)

Central dogma (Crick) → DNA ⟲ (Replication) → DNA —Transcription→ mRNA —Translation→ Protein

Flow of information, Some virus (RNA to DNA) (Reverse transcriptase Reverse transcription (Retro virus)

Packaging of DNA

E. coli → 4.6×10^6 Bp × 0.34 nm = 1.36 mm

→ DNA is package - Basic protein

- Circular DNA, Form large loops with protein (Nucleoid)

Eukaryotes → Human → haploid - 3.3×10^9 Bp (1.1 m)

→ Diploid - 6.6×10^9 Bp (2.2 m)

- 2.2 meter in 10^{-6} m nucleus

- Histone help in packaging

Histone - Rich in lysine & Arginine (Side chain Extra NH_2) — octamer H_2A, H_2B, H_3, H_4

Octamer + DNA → Nucleosome (DNA - 200 Bp H_1 – Sealing)

Beads on string – EM – DNA + nucleosome

NHCs – Higher level packaging

→ $G_1 + S + G_2$ – Chromatin most condense – M-phase

Euchromatin - less condense, light stain

Transcriptionally Active

Heterochromatin – more condense

transcriptionally inactive

Search of Genetic material - Quest to determine genetic material - 1926

Transformation - Bacteria - Pneumonococcus

→ R-strain - non-virulent
→ S-strain - Virulent → Smooth/shiny colony (mucus coat)

Griffith - 1928

R-strain → mice → mice Alive
S-strain - Mice killed
Heat Killed S-strain - Mice alive
R strain + Heat killed S-Strain → Mice killed

Some Tranforming principle - From Heat Killed S - transform R into S (Change into physical Form
↓
(Unknown)

Avery McCarty Macleod - Purified Biochemical

(Prior to work - Protein thought to be Genetic material

(From S-strain
→ RNAse + DNAse → No transformation
→ Protease + DNAse → No transformation
→ Protease + RNAse → Tranformation occur

In presence of DNAse
No Tranformation

Harshey and chase - 1952

Bacteriophage → Genetic material Enter
Lysis occur

S^{35} - Radioactive protein
P^{32} - Radioactive DNA

Virus with S^{35} - Radioactivity - Supernatant
Virus with P^{32} - Pellet Radioactive

Three step - Infection - Genetic material Enter
Blending - cover Removed
Centrifugation - Pellet - E.coli + Virus Genetic material
Supernatant - Virus cover

why DNA is Genetic material

Good Genetic material
(a) Structurally & Chemically stable
(b) Able to make Replica
(c) Slow mutation
(d) Express mendelian pattern

- RNA - Single strand - less stable, Can Act as catalyst, 2'-OH make it labile, Uracil most Reactive
  DNA - Double strand. more stable, 2'-H, thymine → Never Act as catalyst
- DNA & RNA - Both can make copy
- RNA - mutate Faster (RNA virus)
- RNA Express through protein

[ØB bacteriophage + TMV - RNA genetic material

Storage of Genetic information - DNA
Expression - RNA

RNA world – First Genetic material RNA (Splicing, Catalyst) But Unstable
– 2'-OH change to 2'-H & Uracil to thymin ⟶ Single strand to double strand

DNA Replication ⟶ Semi-conservative – one old, one new strand [Watson & Crick – Predicted possible mode of DNA Replication]

semi conservative – 1958 (First – E. coli → Plant → Human) – Plant – Vicia Faba
Messelson & Stahl – E. coli (N^{14} & N^{15} → Heavy isotop
Radioactive thymidine – Taylor – 1958
(Semi conservative in DNA & Chromosome

E. coli ⟶ on N^{15} source (Both strand N^{15}) ⟶ (NH_4Cl, N_{14} source, 20 min) ⟶ Ist Generation 100% Hybrid ⟶ IInd (40 min) 50% Hybrid, 50% light ⟶ 3rd generation (60 min) 25% Hybrid

Detail of DNA Replication

– Prokaryotes – Prior to Fission, Cytoplasm
Faster than Eukaryotes (2000 Bp/sec)
(Semiconservative ↓)
– Eukaryotes – S-phase, Nucleus

R = Replicon → independent Evented DNA Replication
Origin – DNA Replication start – centre of Replicon – origin

At origin – Two Replication Forks

Main Enzyme – DNA polymerase – Direction – 5'–3'
Require primer
Template →
Other name – DNA Dependent DNA polymerase
Substrate – deoxy ribose nucleoside triphosphate
(Dual Role – (i) Substrate
(ii) Energy

Steps in DNA Replication

Helicase – Open DNA

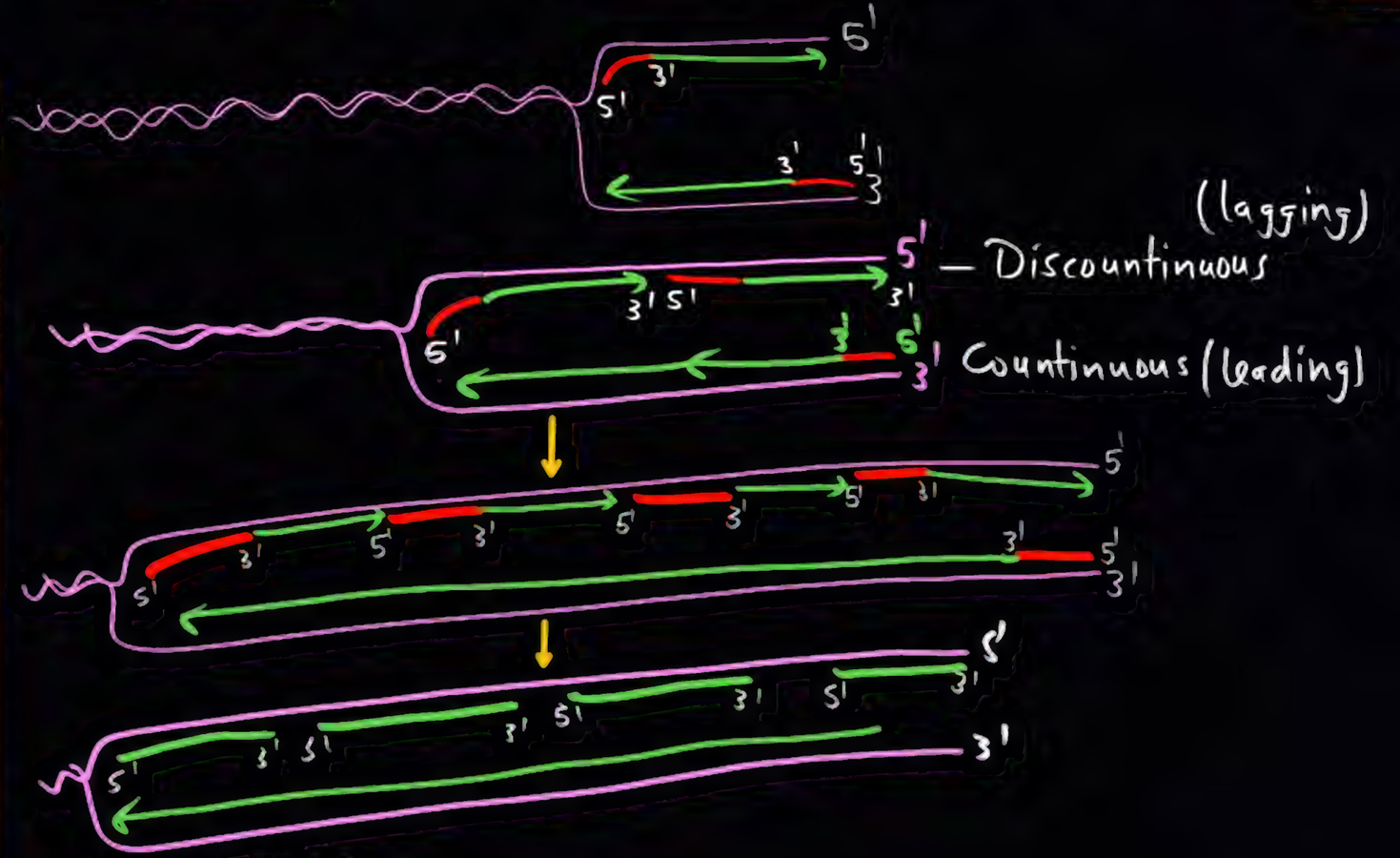
Primase – Primer of RNA

SSB – Keep DNA open

Topoisomerase – dec. –ve supercoiling

DNA polymerase
- Add one nucleotide at 3' end
- So DNA synthesis in 5'–3' Direction

Complete DNA not open at once →



Gap is Filled By

Gap is sealed By

Transcription

- Copying information of DNA into RNA
- RNA is copy → not same But Similar

Location – Cytoplasm (Prokaryotes
Nucleus (Eukaryotes
– all DNA not transcribe

$G_1 + S + G_2$ – Phase – Transcription

Both strand not Act as template
(a) if same time occur – ds RNA Form
(b) If Different time occur – two different protein

steps in transcription

Initiation – RNA polymerase + Sigma Factor
(Recognise Promoter → Small piece of RNA Form

Elongation – Sigma Factor leave
RNA polymerase Act

Termination – RNA polymerase + Rho factor
Recognise terminator Region → RNA leave First
Enzyme leave ← DNA close

Prokaryotes – Cytoplasm, Coupled transcription & translation
Single RNA pol

Eukaryotes → Nucleus, three RNA polymerase

Transcription unit

Independent
Event of transcription
T.U – 1 Gene – monocistronic
T.U – Many Gene – Polycistronic

- P – Promoter – transcription start
attach 5'-end upstream – coding strand
T – Terminator – 3'-end downstream – coding strand

Structural Gene – S.G –
- Template – Actually Function
- Coding – code similar to RNA (U in place of T)

Definition – Gene – Unit of inheritance
Difficult to define in Sequence

– Gene – code For Any type of RNA
– Cistron those gene code For polypeptide

Prokaryotes → 1 transcription unit – many cistron
Eukaryotes – 1 Transcription unit – Single cistron

Eukaryotes – Split gene – Gene give coding Exon
non-coding intron

↓
Reminiscent of Antiquity

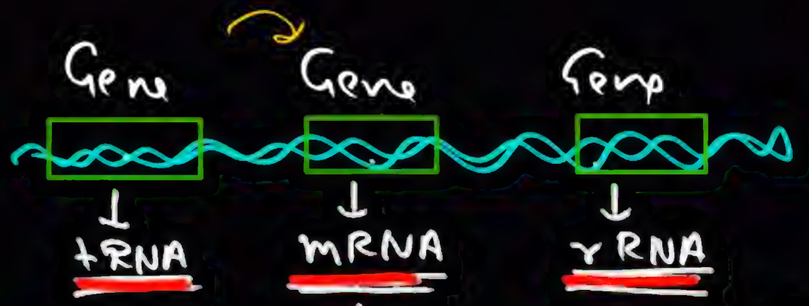
(Transcription Unit & Gene)

Gene → Segment code For Any type of RNA

Cistron – Segment → code For polypeptide
(all cistron Gene But Genes are not
Prokaryotes = 1 Transcription – Many cistron
Unit (Polycistronic)

Eukaryote = 1 TU = 1 Cistron
(Monocistronic)

Eukaryotes Split Gene – Previously
Archaebacteria
hRNA
Intron
mRNA
not in
Eubacteria
Eukaryotes



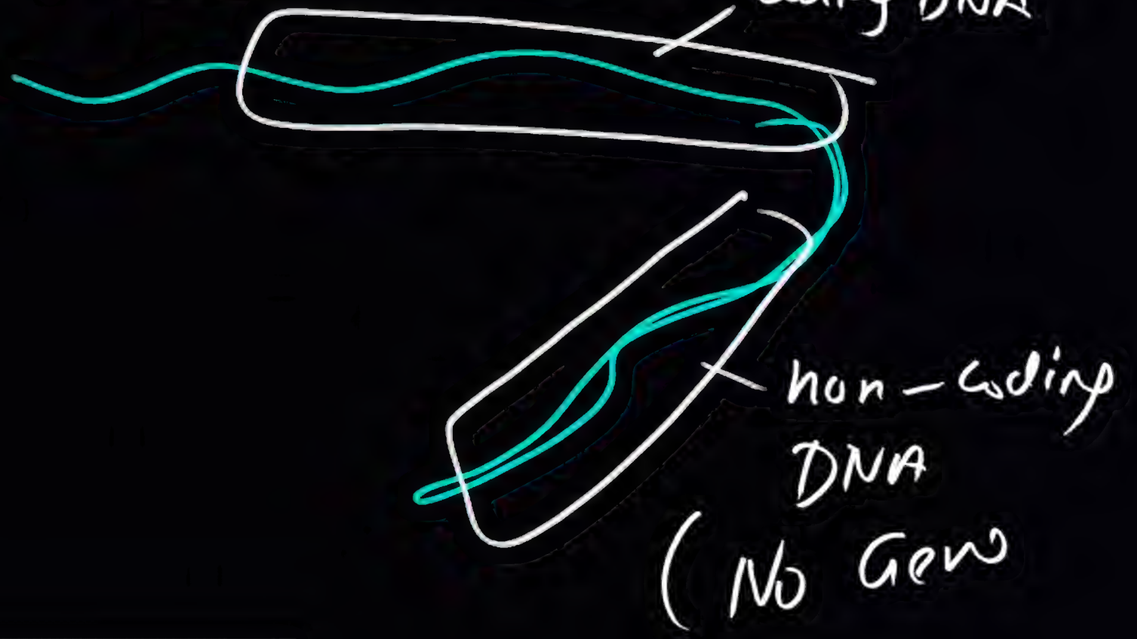
Polypeptide

Eukaryotes
P Cistron T
hnRNA
mRNA → Polypeptide
(Monocistronic)

Prokaryotes
P T
Cistron Cistron Cistron
mRNA
mRNA
mRNA
Poly
Polypeptide
Polypeptide
(Polycistronic)

Gene → tRNA
→ rRNA
→ T.U = Gene (split Gene) (Eukaryote)
→ Many Gene = T.U
→ Regulatory sequen = Gene
→ Regulator Gene

Regulatory Gene
Gene
Cistron = 3
P
T
mRNA
Regulator protein
Regulatory sequence = operator
tRNA
rRNA
(not Form RNA



cell theory

Type of RNA

23 sr RNA

- r RNA – ribosomal RNA → Catalyst (Ribozyme) + Structural (most stable Abundant)
- t-RNA – transfer RNA, Soluble RNA, Read code on mRNA, Bring A.A on Ribosome
- hnRNA → modify into mRNA
- Sn RNA → Small nuclear RNA (splicing)
- Sc RNA – Small cytoplasmic RNA (SRP)

Transfer RNA – Soluble, Adapter

Crick – Adapter hypothesis – Amino Acid can not Read code, Some Adapter present

t-RNA Discovered → Genetic code → Role of t-RNA

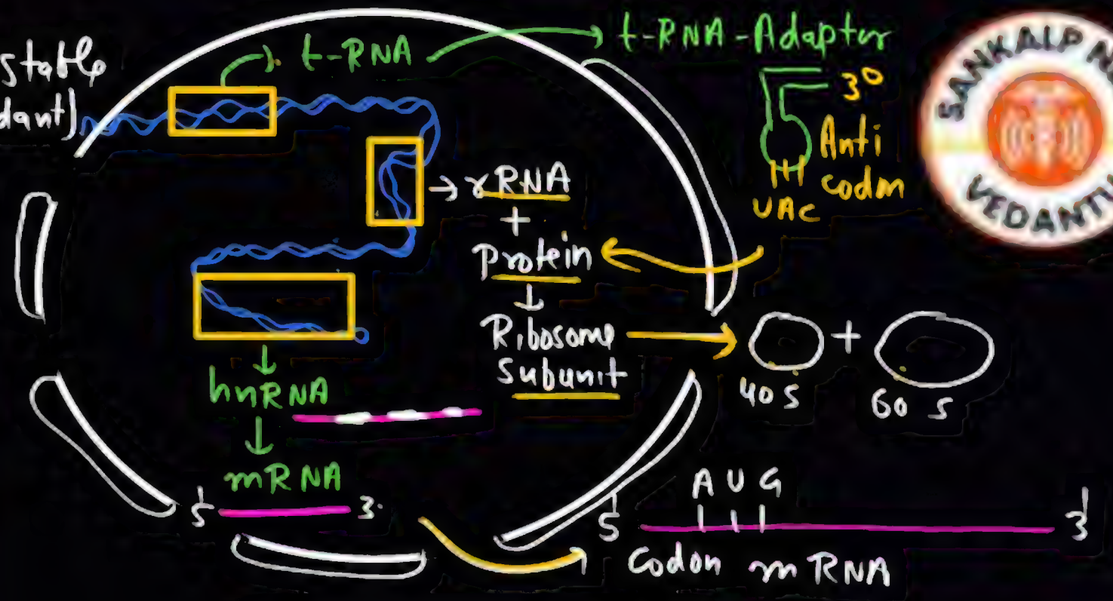
1° → 2° → 3' → A.A Acceptor Arm → 3° (Functional) inverted L-shape

Clover leaf

Anticodon Arm

- no t-RNA For stop codon ✓
- Functional is – inverted L-shape
- Different initiator codon

Prokaryotes		Eukaryotes	
RNA polymerase	r RNA	RNA pol I – r	28 S, 5.8, 18 S
	t RNA	RNA Pol II – h	
	mRNA	RNA Pol III – t	5 S r RNA



Ribosomal RNA (r RNA)

80 S → 60 S → 28 S, 5.8 S, 5 S] 80 type protein
80 S → 40 S → 18 S (nucleolus)]

70 S → 50 S → 23 S, 5 S
70 S → 30 S → 16 S

Post transcriptional modification

hnRNA (less stable) → PTM → mRNA

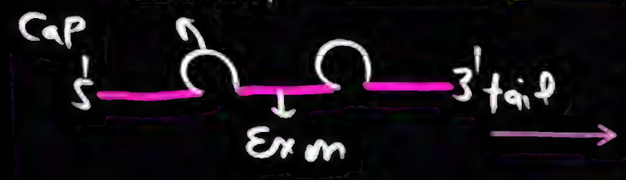
Capping — m⁷G 5′ (7-methyl Guanosine tri phosphate)

tailing — AAA 3′ (200–300 polyAdenylate)

Intron — not come in processed RNA

Exon — come in processed RNA

splicing [Removal of intron & Linking of Exon



→ 5′ — mRNA — 3′ (smaller than hnRNA) (Use in Reverse transcription)

Stability → rRNA > tRNA > mRNA > hnRNA

Amount → rRNA > tRNA > mRNA

Smallest — tRNA

Genetic code

DNA Replication, transcription — Complimentary Base pairing

Translation — no such Relation

deciphering — How much nucleotide — 1 A·A which set of nucleotide For which A·A

(organic chemist, Biochemist, Geneticist, physicist

Meth — AUG

Trp — UGG

UUU — Phe

George Gamow — Genetic code triplet

4^1 = 4 code 4^2 = 16 code 4^3 = 64 code

UAA, UGA, UAG — stop codon

Severo ochoa — Polynucleotide phosphorylase

Nirenberg — Cell Free Synthesis of protein (deciphering)

H. G Khorana

Salient Feature

(a) Triplet ✓

(b) AUG — start codon — Dual Role (start & mid)

UGA, UAG, UAA } stop codon

(c) Without punctuation ✓

(d) nearly Universal (Except — some protozoa, Mitochondria ✓

(e) degenerate

Glycine → GGG, GGC

If Unambiguous → GGG → Glycine

GGG ✗ → Leucin

Mutation → substitution (SCA) — one A·A change

Deletion & Addition — FRAME Shift

RAM HAS RED CAP

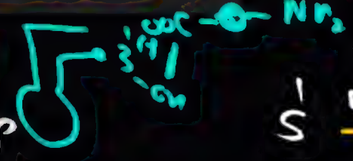
Translation – location - Cytoplasm

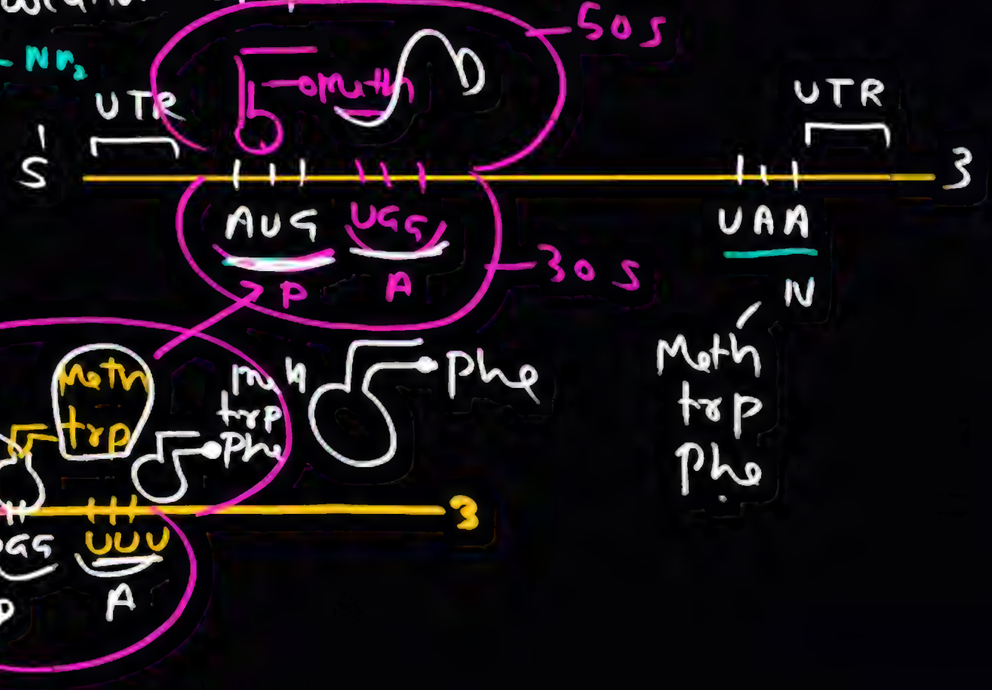
[Charging of t-RNA

Amino Acid + ATP → Amino AcylPAMP

Amino Acyl AMP + t RNA → Charge t-RNA + AMP

Enzyme – Amino Acyl t-RNA synthetase



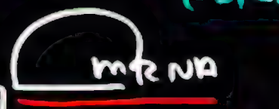


Steps

(a) mRNA + Small Subunit

(b) Charge t-RNA at P-site

(c) large Subunit



(d) Charge t-RNA at - A site ✓ 23S

(e) Peptide Bond Form ✓ (Peptidyl transferase)

(f) t-RNA Empt at P-site move out

(g) Ribosome move Forward

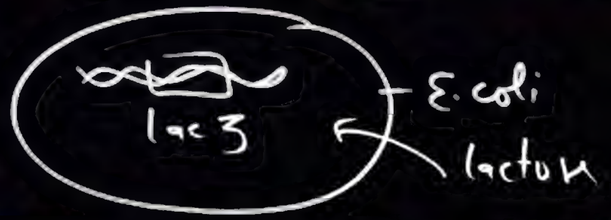
(h) Stop codon at A-site

no t-RNA → Release Factor At

Regulation of Gene Expression

Need - Metabolic, Development, Environment, Physiologies

Levels → Transcription
PTM
Prokaryotes – Transport
– Translation
] Eukaryotes



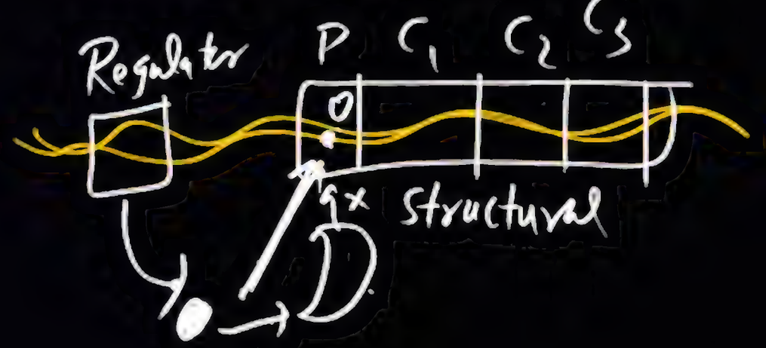
(tRNA, rRNA, mRNA)

Always

Constitutive → Express
non-constitutive → control

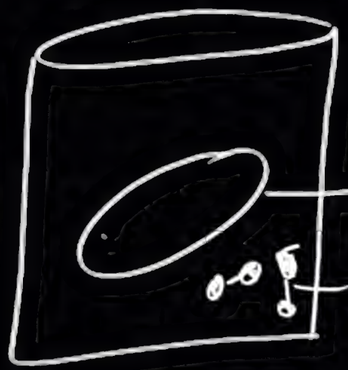
Type of Gene — Structural — Enzymes
Regulator → Regulator → protein
Stop (-ve)
Promoter (+ve)

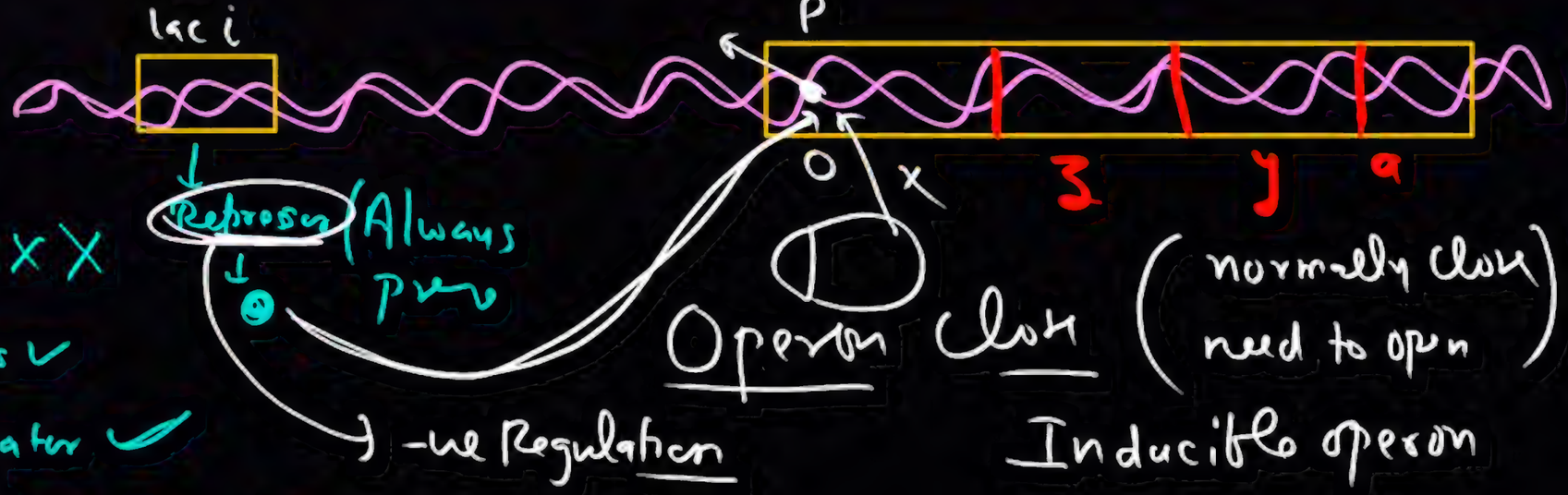
Concept of Operon



Glu - Gular

1 galactosidase ✓ (lactose (Glycosidic)
2 Permease ✓ → channel
3 transacetylase ✓





Case - I

lactose X X

↓

Repress ✓

↓

Bind on Operator ✓

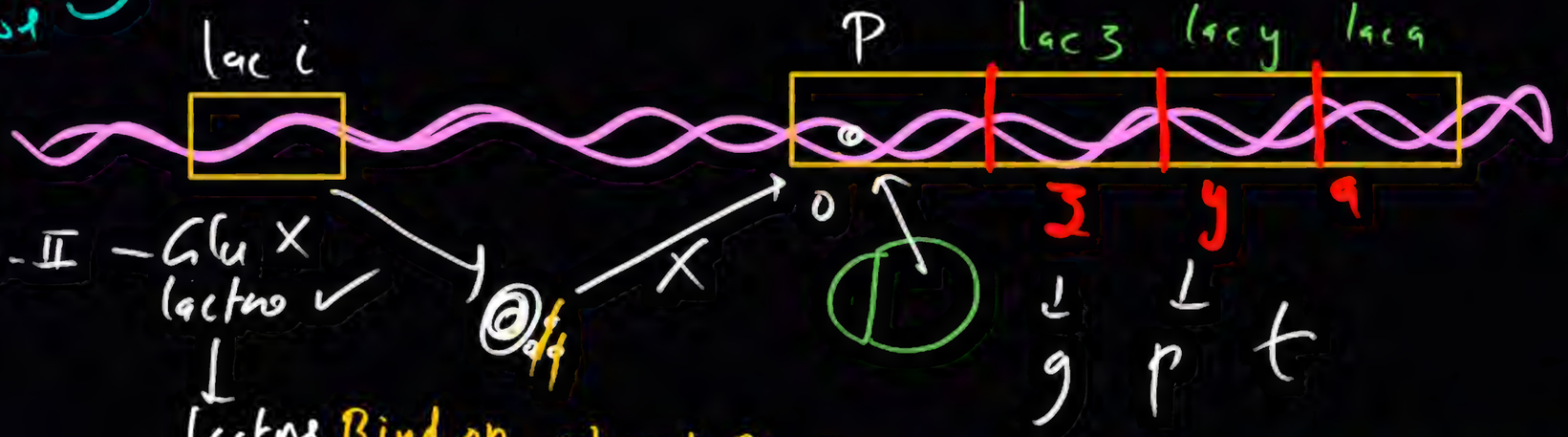
↓

Prevent transcription

↓

Stop RNA pol

Z	
Y	
a	



Case - II - Glu X lactose ✓

↓

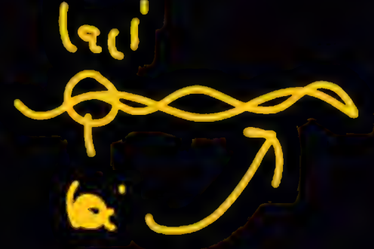
lactose Bind on Repressor → not Bind on operator → RNA Polymerase transcription

g p t

Transcription

Promote = lactose (Inducer)

DOPA



Q1 In E.coli main control of Gene Expression
(a) Transcription (b) Translation (c) transport (d) all

Q2 lactose metabolism Enzyme in E.coli is
(a) control By common promoter (b) Always Express (c) constitutive (d) all

Q3 constitutive Gene is (Regulator Gene)
(a) lac i (b) lac z (c) lac y (d) lac a

Q4 lac operon is Switch on when
(a) lactose present Glucose present (c) lactose Abrent Glucose present (d) Glucose Abrent lactose present (all)

Q5 B-Galactosidase is
(a) Part of operon control (b) Part of polycistronic Arrangement (c) Structural Gene (d) all

Q6 In lac operon, when lac i gene Express, No lactose in medium (which is correct)
(a) Repressor not Bind on operator (b) RNA polymerase Bind on operator (c) One structural gene Express (d) Negative Regulation occur

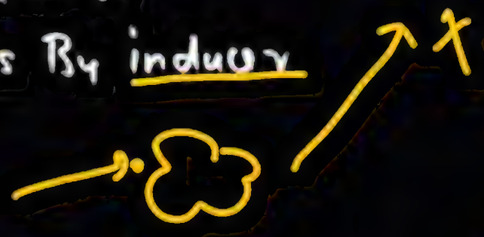
Q7 lac operon is inducible operon because

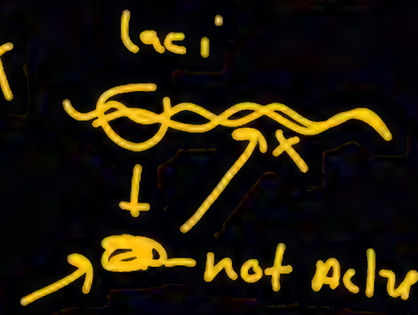
(a) In General structural Gene not Express

(b) In General structural Gene Express ✗

(c) In General structural gene off can be Express By inducer

(d) all





Q8 In lac operon inducer is

(a) lactose (b) Allolactose (c) Substrate (d) all

Q9 Inducer in lac operon

(a) Activate Regulator gene (b) Regulate Regulator + structural Gene (c) Inactivate Repressor protein (d) Activate Repressor protein

Q10 Small level of lac operon Expression is present

(a) Some time (b) Always For lactose Hydrolysis (c) Always For lactose Entry (d) all

Q11 Mutation in lac i gene

(a) Operon Always close ✗ (b) Repressor not Form (c) Inactive Repressor (d) all both b & c

Q12 RNA polymerase not Bind on promoter when –

(a) lac i inactive (b) lac i active (c) Repressor not Active (d) lactose present

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Organism and population

lecture- 02

Botany

TARUN SIR

Organism and population

Abiotic Factor

effect of Abiotic factor

Adaptation

Population Attribute

Population Growth

Population Growth model

Population interaction

Basic introduction

- complexity present at all level of organization
- At All levels we try to Answer → 'How' and Why

Ex- Bird Singing → How

Why

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Our living world is fascinatingly diverse and amazingly complex. We can try to understand its complexity by investigating processes at various levels of biological organisation–macromolecules, cells, tissues, organs, individual organisms, population, communities, ecosystems and biomes. At any level of biological organisation we can ask two types of questions – for example, when we hear the bulbul singing early morning in the garden, we may ask – 'How does the bird sing?' Or, 'Why does the bird sing ?' The 'how-type' questions seek the *mechanism* behind the process while the 'why-type' questions seek the *significance* of the process. For the first question in our example, the answer might be in terms of the operation of the voice box and the vibrating bone in the bird, whereas for the second question the answer may lie in the bird's need to communicate with its mate during breeding season. When you observe nature around you with a scientific frame of mind you will certainly come up with many interesting questions of both types - *Why are night-blooming flowers generally white? How does the bee know which flower has nectar? Why does cactus have so many thorns? How does the chick spures recognise her own mother?*, and so on.

What is Ecology

Biotic

Biotic

Abiotic

Abiotic

(a) Soil Formation is interaction of
(a) Air & water with soil
(b) Help of lichen
(c) decomposition By Microbes
(d) all

levels of Ecology

- Organism
- Population
- Community
- Biome

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You have already learnt in previous classes that Ecology is a subject which studies the interactions among organisms and between the organism and its physical (abiotic) environment.

Ecology is basically concerned with four levels of biological organisation – organisms, populations, communities and biomes. In this chapter we explore ecology at population levels.

Organism Level Ecology

Abiotic Factors

- temperature
- water
- Light
- Soil

Response of Biotic with Abiotic

Response to Abiotic

Why change in condition Impact

Homeostasis

Conformer

Regulator

Partial Regulator

Response to change condition

Migration

Suspension

Adaptation

Population

definition – Group of organism of same species living in a common Geographical Area Share and Compete For Resources and Can interbreed

Interbreed

which is population According to Ecologist (not Genitcist)

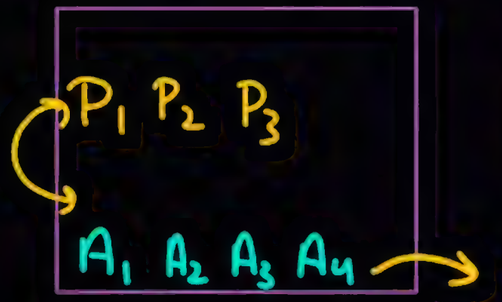
(a) Rose By stem cutting

(b) Mango plants By seed

(c) Fungi From Fragmentation

(d) Both a & c

Population



Q1 Acc. to Ecologist population is
(a) Group of Hydra By Budding
(b) Group of Chlamydomonas By Zoospore
(c) Puppies of dod
(d) all

Q2 Acc. to Ecologist population is
(a) Grow and parrot on same tree
(b) Four grass
(c) one Grass & one maize (d) all

11.1 Populations

11.1.1 Population Attributes

In nature, we rarely find isolated, single individuals of any species; majority of them live in groups in a well defined geographical area, share or compete for similar resources, potentially interbreed and thus constitute a population. Although the term interbreeding implies sexual reproduction, a group of individuals resulting from even asexual reproduction is also generally considered a population for the purpose of ecological studies. All the cormorants in a wetland, rats in an abandoned dwelling, teakwood trees in a forest tract, bacteria in a culture plate and lotus plants in a pond, are some examples of a population. In earlier chapters you have learnt that although an individual organism is the one that has to cope with a changed environment, it is at the population level that natural selection operates to evolve the desired traits. Population ecology is, therefore, an important area because it links ecology to population genetics and evolution.

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Attributes to Describe population

I Birth rate

II Death Rate

III Sex Ratio

Q1 In a pond with 20 lotus, after one year total 24 lotus calculate Birth rate

Q2 In laboratory 40 Fruit fly, After week 4 Dies, calculate death rate

Q3 In a wet lands 200 cormorants, After month 150 Remains, calculate death Rate

Age distribution

Type of Population

Expanding

Stabilizing

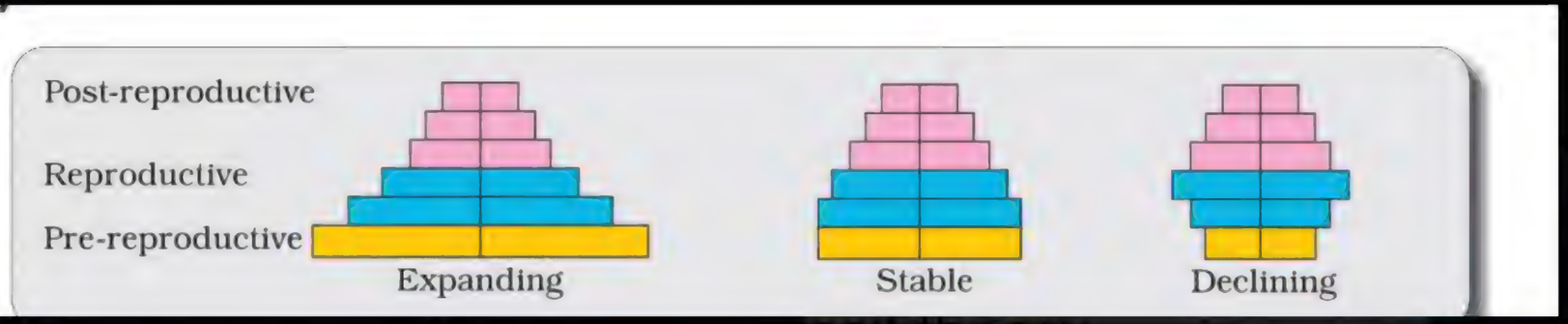
Declining

and evolution.

A population has certain attributes whereas, an individual organism does not. An individual may have births and deaths, but a population has *birth rates* and *death rates*. In a population these rates refer to *per capita* births and deaths. The rates, hence, expressed are change in numbers (increase or decrease) with respect to members of the population. Here is an example. If in a pond there were 20 lotus plants last year and through reproduction 8 new plants are added, taking the current population to 28, we calculate the birth rate as 8/20 = 0.4 offspring per lotus per year. If 4 individuals in a laboratory population of 40 fruitflies died during a specified time interval, say a week, the death rate in the population during that period is 4/40 = 0.1 individuals per fruitfly per week.

Another attribute characteristic of a population is *sex ratio*. An individual is either a male or a female but a population has a sex ratio (e.g., 60 per cent of the population are females and 40 per cent males).

A population at any given time is composed of individuals of different ages. If the age distribution (per cent individuals of a given age or age group) is plotted for the population, the resulting structure is called an age pyramid (Figure 11.1). For human population, the age pyramids generally show age distribution of males and females in a diagram. The shape of the pyramids reflects the growth status of the population - (a) whether it is growing, (b) stable or (c) declining.


Post-reproductive
Reproductive
Pre-reproductive
Expanding
Stable
Declining

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5 Population density – It is no. of individual in Given Area, Best method is

Size of population depend on

other method

Banyan and parthenium

Bacteria

Fish in Pond

tiger

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The size of the population tells us a lot about its status in the habitat. Whatever ecological processes we wish to investigate in a population, be it the outcome of competition with another species, the impact of a predator or the effect of a pesticide application, we always evaluate them in terms of any change in the population size. The size, in nature, could be as low as <10 (Siberian cranes at Bharatpur wetlands in any year) or go into millions (*Chlamydomonas* in a pond). Population size, technically called **population density** (designated as N), need not necessarily be measured in numbers only. Although total number is generally the most appropriate measure of population density, it is in some cases either meaningless or difficult to determine. In an area, if there are 200 carrot grass (*Parthenium hysterophorus*) plants but only a single huge banyan tree with a large canopy, stating that the population density of banyan is low relative to that of carrot grass amounts to underestimating the enormous role of the Banyan in that community. In such cases, the per

grass (*Parthenium hysterophorus*) plants but only a single huge banyan tree with a large canopy, stating that the population density of banyan is low relative to that of carrot grass amounts to underestimating the enormous role of the Banyan in that community. In such cases, the per cent cover or biomass is a more meaningful measure of the population size. Total number is again not an easily adoptable measure if the population is huge and counting is impossible or very time-consuming. *If you have a dense laboratory culture of bacteria in a petri dish what is the best measure to report its density?* Sometimes, for certain ecological investigations, there is no need to know the absolute population densities; relative densities serve the purpose equally well. For instance, the number of fish caught per trap is good enough measure of its total population density in the lake. We are mostly obliged to estimate population sizes indirectly, without actually counting them or seeing them. The tiger census in our national parks and tiger reserves is often based on pug marks and fecal pellets.

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Population Growth

- Population Size is not Static Parameter, it chage with
- Four Basic process Affect Population Growth

Natality

Mortality

migration

Emmigration

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11.1.2 Population Growth

The size of a population for any species is not a static parameter. It keeps changing with time, depending on various factors including food availability, predation pressure and adverse weather. In fact, it is these changes in population density that give us some idea of what is happening to the population – whether it is flourishing or declining. Whatever might be the ultimate reasons, the density of a population in a given habitat during a given period, fluctuates due to changes in four basic processes,

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two of which (natality and immigration) contribute to an increase in population density and two (mortality and emigration) to a decrease.

(i) ***Natality*** refers to the number of births during a given period in the population that are added to the initial density.

(ii) ***Mortality*** is the number of deaths in the population during a given period.

(iii) ***Immigration*** is the number of individuals of the same species that have come into the habitat from elsewhere during the time period under consideration.

(iv) ***Emigration*** is the number of individuals of the population who left the habitat and gone elsewhere during the time period under consideration.

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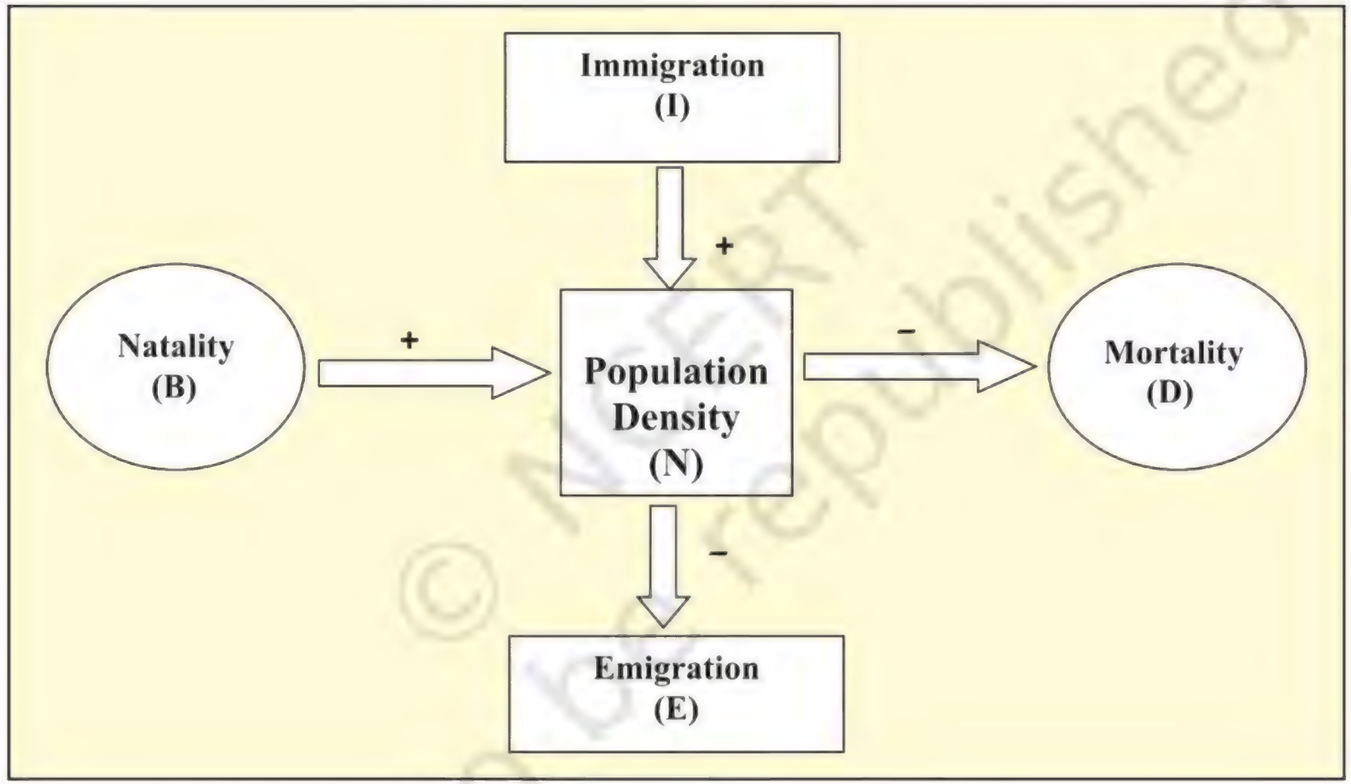

Figure 11.2

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Growth Model For population

Any pattern For Growth is visible

Two type of model ⟶

(a) Exponential Growth Model

(b) Logistic Growth model

Exponential Growth model

condition – If Resources (Food & Space) — Unlimited Any population can Grow Exponentially

$$\frac{dN}{dt} = rN \quad (r = b - d)$$

$$N_T = N_0 e^{rt}$$

N = population

t = time

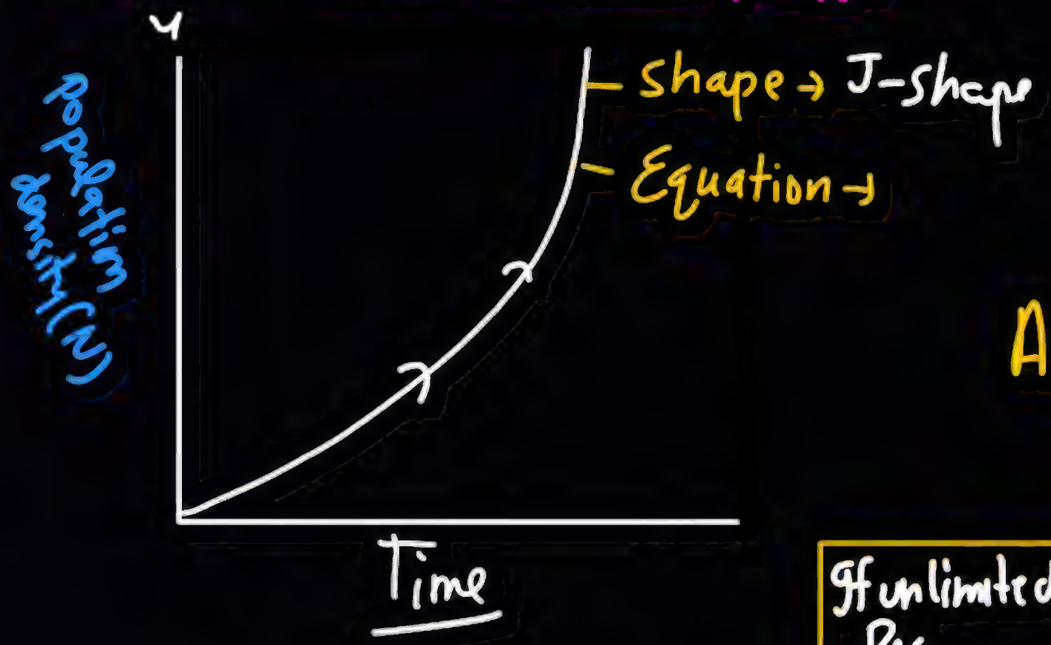
r = b − d (birth rate − death rate)

Intrinsic Rate of natural increase (depend on Biotic & Abiotic Factor)

N_T = Final population density

N_0 = initial population density

e = base of natural logarithm (NEET-2022)



1981-India population	$r = 0.0205$
Norway Rat	$r = 0.015$
Flour Beetle	$r = 0.12$

Anecdote (किंवदंती) – King & Minister (Bet)

Chess Board → 1 Grain → 2 Grain → 4 Grain

If unlimited Resources → Exponential model Follow → Elephant can also Grow Exponentially

logistic growth model

Verhulst pearl logistic growth curve

Condition – No population can grow Exponentially
(Food & Space is limited)

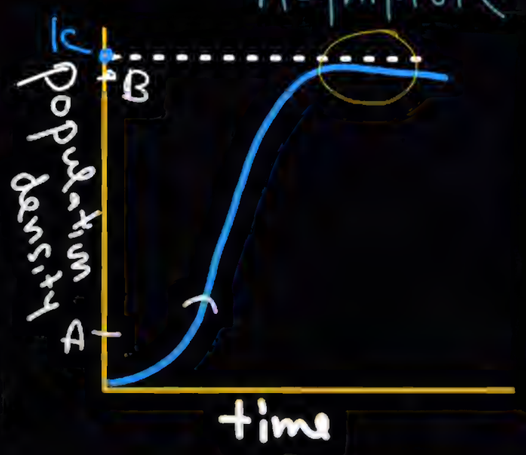
$$\frac{dN}{dt} = rN\left(\frac{K-N}{K}\right)$$

N never be Greater than K

Carrying capacity = K

Maximum number of individual of Species Supported By Habitat through Resources

It depend on →
(a) Size of organism
(b) Life span
(c) type of Habitat



Case I When $K >> N$ [K = 200 Elephant, N = 5 Elephant]

$$\frac{dN}{dt} = rN\left(\frac{K-N}{K} \to N\text{- Neglect}\right)$$

$$\frac{dN}{dt} = rN \text{ (Exponential)}$$

Case II When N is Equal to K (Point B)

$$\frac{dN}{dt} = rN\left(\frac{K-N}{K} \to \text{Zero}\right)$$

$$\boxed{\frac{dN}{dt} = 0}$$

N = Constant (Graph → Asymptote)

Q1 Carrying capacity depend on

(a) type of species (b) Habitat (c) life span of organism (d) all

Q2 Which is not possible → Asymptote

(a) $N < K$ (b) $N = K$ (c) $N > K$ (d) $K = 0$

Q3 When population is very low then Rate of population Growth

(a) $\frac{dN}{dt} = rN$ (b) $\frac{dN}{dt} = rN\left(\frac{K-N}{K}\right)$ (c) $\frac{dN}{dt} = rN\left(1-\frac{N}{K}\right)$ (d) none

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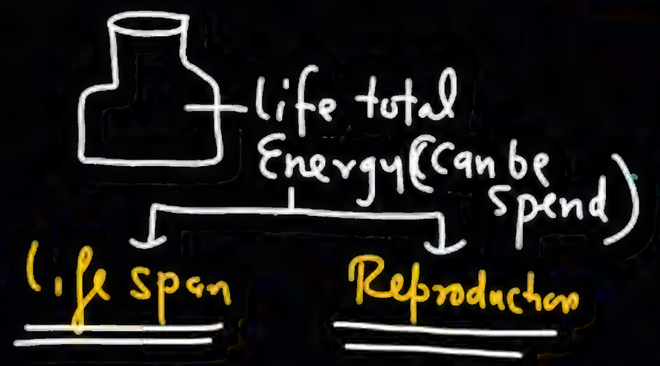
Life History variation

Species inc → r – Darwinian Fitness

Bamboo
Pacific Salmon Fish
Oyster, Pelagic Fish
→ one time Reproduce
→ large offspring

Mammals
Birds
(long lifespan
less progeny)



Insect → 10 day – life span
(less time Reproduce
More no progeny)

Mammals – life span More → many time Reproduce
↓
Each time less progeny Form

Population interaction

In Any Habitat → Single population not present
– More than one population present
– Species of population → (interaction show)

		Positive (+) (Benefit)	Negative (–)	Neutral (0)
		Species A	Species B	
1	competition	–	–	
2	Predation	+ (Predator)	– (Prey)	
3	Parasitism	+ Parasite	– Host	
4	Ammensalism	0	–	
5	commensalism	0	+	
6	Mutualism	+	+	

Q Interaction in which Atleast one Get harm
(a) 1,2,3 (b) 1,2,5 (c) 1,2,3,4 (d) all

Q Interaction in which Atleast one get Benefit
(a) 1,2,3 (b) 2,3,5 (c) 2,3,5,6 (d) 2,3

Ammensalism

Alaxandor Flemming Antibiotic Discover →

Staphylococcus not Grow Due to Fungi)

Staphylococcus (–)
Penicillium (0)

Predation – Predator – + Prey → –

Prudent

Example – ① Lion Eating deer
② Cow/Cattle Eating Grass (–)
(3) Bird Eating Grain/Seed (Embryo present)

Role →

(a) Flow (Conduit) of Energy in Food chain

(b) Control population of Prey → Ex-Prickly Pear cactus → Introduce Australia → Spread very Fast → Population control → By Moth ← (natural predator)

(c) Maintain Biodiversity →

(Pisater predator
Remove → Some prey do overfeeding

Pacific Coast
Star Fish (Species) (Pisaster) → Important Predator → Pisaster Remove (10 invertebrate Extinct)

Adaptation – In Animals (to Avoid predator)

(a) Comuflage → Blend with Surrounding
(Grass hopper not visible in Grass

(b) Poison in Insect (Prey) → Monarch Butterfly is poisonous
Poisonous (Acquive poison when larvae
Feed on Poisonous weed)

(c) Warning Colouration → Some Frog Bright Colour Predator not Attack

(d) Mimicry (By Prey which is non-Poisonous mimic Poisonous prey

Adaptation in plants — to Avoid predater

- 25% insects are phytophagus (Eat plant), Plant can also not Run

(Plant Evolve Anatomical & Biochemical Adaptations → to protect itself from insect

- Plant Adaptation – ① thorns & spines (Citrus, Bougainvillea)

② Some chemicals → Caffiene, Nicotine, opium, Strycine
(Secondary Metabolite) not like By Animal

③ Plant – Calotropis → Milk weed → Produce white Sap
which → which cause Uneasyness in Animals

Prudent Behaviour of Predator →

Predator is Efficient → not Kill all prey at a time)

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Organism and population

lecture- 03

Botany

TARUN SIR

Organism and population

Abiotic Factor

effect of Abiotic factor

Adaptation

Population Attribute

Population Growth

Population Growth model

Population interaction

Competition – Species A → – Specis → –

(Darwin → interspecific Competition is potent Force For Evolution

old definition → It is a interaction B/w two closely related species For limited resources

(this is not true Always → Ex- Not Always Competition is B/w Closely Related

In south American lake → Fish and Flamingo compete For Zooplankton
But Fish and Flamingo not closely Related

Ex – Galapagos Island → Goat introduce → Abingdon tortoise get Extinct
(Food was unlimited But Due to Grazing Efficiency of Goat, Abingdon tortoise Extinct → interference competetion)

New definition → Competion decrease 'r' of each other (r = biotic potential)

Support of this definition: ① Interference competition (presence of Goat decrease 'r' of tortoise

② Competitive Release → Due to presence of superior specien, inferior species number limited when we Remove Superior specien → Suddenly number of inferior specien increase

→ Scotland coast → Barnacle → Balanus (superior), Cathamalus (inferior) → If We Remove Balanus Cathamalus no. Inc. (Conell's Field Experiment)

(Balanus decreased 'r' of cathamalus

Effect of competition → ① decrease 'r'

② Cause competitive Exclusion principle → In Any Area two competing species can not live indefinitely → Superior specien Exclude inferior Specien (Condition → Resources limited)

How to Avoid competition → Resource partitioning (PYQ) → Mac arther Warblers (Birds) ① Different Foraging pattern → to Avoid competition (Feeding)

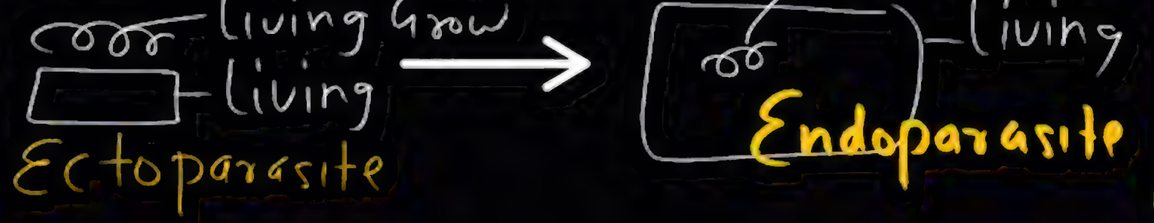
② Different time of Feeding

Parasitism (host → − Parasite ∃ +)

Parasite get → Free Space (lodging) and Food

Co evolution → Parasite Evolve to cause maximum harm to host & host Evole to protect itself [Co evolution]

How parasitism Evolve → (Saprophyte) living Grow → dead



This also possible Endoparasite Convert into Mutualism

Adaptation in parasite →

(a) Alimentary Canal - Glands Absent
(b) Bisexual
(c) Hooks & Sucker
(d) High Reproduction capacity
(e) Sensory Organ Absent
(f) Two Host (Digenetic life cycle)

Ex - Liver Fluke (Snail & Fish)

Effect parasitism → ① Reduce Reproduction Capacity of host
(b) Cause disease (3) interfere with life cycle
④ Host is so weak (it is more prone to Predation (chance))

Ectoparasite

- Present on host Surface
- Life cycle not very complex

Example → Lice in Human ticks on Dog
→ Copepod on Marine Fish
→ Cuscuta on plant as parasite (no chlorophyll)

Endoparasite

- Present inside host
- Life cycle complex
- Present- liver, Alimentary canal, Blood & lungs

Ex- liverflute, tapeworm, Filarial worm

Note → Mosquito not considered as parasite on human → As Mosquito Feed on plant sap

Brood parasitism →

nest of crow

Cuckoo Bird lay Egg in Nest of Crow → Crow take Care (Feed) Cuckoo bird Egg & Progeny

With time → Egg of Cuckoo Bird get Similar in Colour & shape to Egg of Crow

Commensalism

Species – +
Species – 0

One Species Get Benefitted, other species not harm or Benefit

Examples

I orchids and Mango tree → (+) (0)

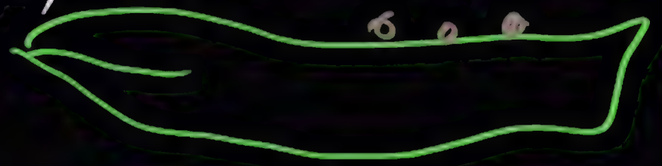
→ orchid Present on Branch on Mango tree (Epiphyte)
- Benefit → Sunlight
- have tissue → Velamen (Absorb Moisture From Air)

II Cattle Egret and cattle → (+) (0)
When cattle Eat on Grass → Pull Grass
(Insect come out → Eaten By Bird (Cattle Egret) → Bird Eat insect)

III Sea Anemore and Clown Fish → (0) (+)

Sea Anemone (tentacle have Cnidoblast)
↳ Clown Fish (Protect From predator)

(IV) Whale and Barnacle (+) (0)



→ Barnacle travel to new place & Get Food)

Mutualism (Species A – + Species B → +)

Lichen → Algae – Give Food
Fungi – Shelter + mineral

Mycorhizae → Fungi → Mineral
Higher plant → Give Food to Fungi

→ Symbiotic Association (Physically linked)

Pollinator → Insect (get nectar) + Plant (Pollination)

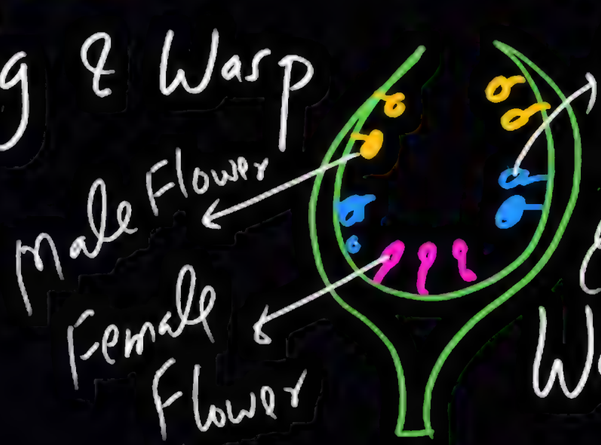
seed dispersal → Animal (Eat Fruit) + Plant (Get seed dispersal)

Some time pollinator can cheat → Plant Evolve Some obligatory (Sexual deceit)

This is an Example of Sexual deceit

(a) Yucca plant and Moth (Moth larvae need pollen of Yucca plant)

(b) Fig & Wasp



} Inflorescence of Fig

Male Bee → Benefit → Sexual desire Complete But Pseudo copulate

Ophrys (Pollination)

Orchid Flower (Resemble to Female Bee)

resources need not be limiting for competition to occur; in interference competition, the feeding efficiency of one species might be reduced due to the interfering and inhibitory presence of the other species, even if resources (food and space) are abundant. Therefore, competition is best defined as a process in which the fitness of one species (measured in terms of its 'r' the intrinsic rate of increase) is significantly lower in the presence of another species. It is relatively easy to demonstrate in laboratory experiments, as Gause and other experimental ecologists did, when resources are limited the competitively superior species will eventually eliminate the other species, but evidence for such competitive exclusion occurring in nature is not always conclusive. Strong and persuasive circumstantial evidence does exist however in some cases. The Abingdon tortoise in Galapagos Islands became extinct within a decade after goats were introduced on the island, apparently due to the greater browsing efficiency of the goats. Another evidence for

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Competitive Exclusion

(ii) ***Competition***: When Darwin spoke of the struggle for existence and survival of the fittest in nature, he was convinced that interspecific competition is a potent force in organic evolution. It is generally believed that competition occurs when closely related species compete for the same resources that are limiting, but this is not entirely true. Firstly, totally unrelated species could also compete for the same resource. For instance, in some shallow South American lakes, visiting flamingoes and resident fishes compete for their common food, the zooplankton in the lake. Secondly, resources need not be limiting for competition to occur; in interference competition, the feeding efficiency of one species might be reduced due to the interfering and inhibitory presence of the other species, even if resources (food and space) are abundant.

the occurrence of competition in nature comes from what is called 'competitive release' A species whose distribution is restricted to a small geographical area because of the presence of a competitively superior species, is found to expand its distributional range dramatically when the competing species is experimentally removed. Connell's elegant field experiments showed that on the rocky sea coasts of Scotland, the larger and competitively superior barnacle *Balanus* dominates the intertidal area, and excludes the smaller barnacle *Chathamalus* from that zone. In general, herbivores and plants appear to be more adversely affected by competition than carnivores.

Plant → herbivore → carnivore

Gause's '*Competitive Exclusion Principle*' states that two closely related species competing for the same resources cannot co-exist indefinitely and the competitively inferior one will be eliminated eventually. This may be true if resources are limiting, but not otherwise. More recent studies do not support such gross generalisations about competition. While they do not rule out the occurrence of interspecific competition in nature, they point out that species facing competition might evolve mechanisms that promote co-existence rather than exclusion. One such mechanism is 'resource partitioning'. If two species compete for the same resource, they could avoid competition by choosing, for instance, different times for feeding or different foraging patterns. MacArthur showed that five closely related species of warblers living on the same tree were able to avoid competition and co-exist due to behavioural differences in their foraging activities.

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Microbes in Human welfare

Botany

TARUN SIR

Topics

Example of Microbe

Household product

Industrial product

Sewage treatment plant

Biogas plant

Biocontrol Agents

Biofertilizers

Introduction

What are microbe → microscopic (small size – not visible in naked eye

Examples:- Bacteria, Protista, Fungi, Virus, Viroids, Prions

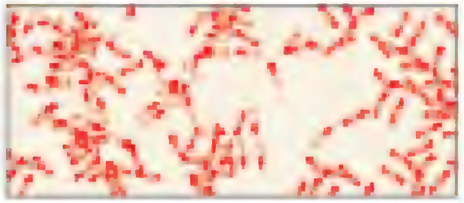
kingdom it belong ⟶ Monera, Protista, Fungi (mainly)

Found in Habitat → Soil, Air & water

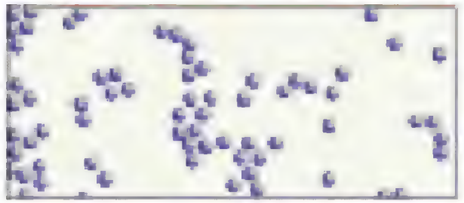
Unusual – deep soil, Hot water, Snow, Desert
inside gut

visible with naked Eye ⟶ Bacteria & Fungi – can be cultured

Colony Form ⟶ Visible By naked eye



(a)



(b)

(c)

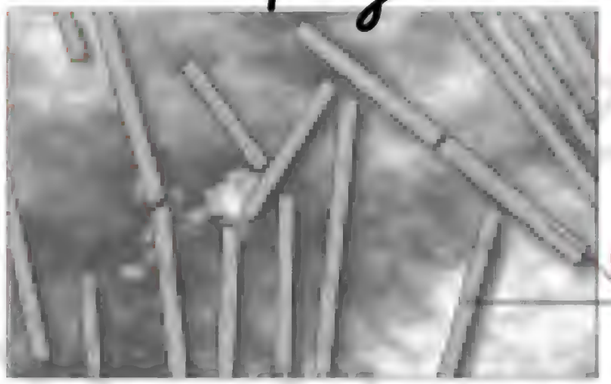
Figure 8.1 Bacteria: (a) Rod-shaped, magnified 1500X; (b) Spherical shaped, magnified1500X; (c) A rod-shaped bacterium showing flagella, magnified 50,000X

(a)

(b)

Bacteriophage

Adenovirus (Respiratory infection)



TMV

(c)

Figure 8.2 Viruses: (a) A bacteriophage; (b) Adenovirus which causes respiratory infections; (c) Rod-shaped Tobacco Mosaic Virus (TMV). Magnified about 1,00,000–1,50,000X

Besides macroscopic plants and animals, microbes are the major components of biological systems on this earth. You have studied about the diversity of living organisms in Class XI. *Do you remember which Kingdoms among the living organisms contain micro-organisms? Which are the ones that are only microscopic?* Microbes are present everywhere – in soil, water, air, inside our bodies and that of other animals and plants. They are present even at sites where no other life-form could possibly exist – sites such as deep inside the geysers (thermal vents) where the temperature may be as high as 100°C, deep in the soil, under the layers of snow several metres thick, and in highly acidic environments. Microbes are diverse – protozoa, bacteria, fungi and microscopic animal and plant viruses, viroids and also prions that are proteinacious infectious agents. Some of the microbes are shown in Figures 8.1 and 8.2.

Microbes like bacteria and many fungi can be grown on nutritive media to form colonies (Figure 8.3), that can be seen with the naked eyes. Such cultures are useful in studies on micro-organisms.

A- # Lactic Acid Bacteria (I Household products)

Example – lactobacillus + other Bacteria → together called LAB – lactic Acid Bacteria

Role → Curd making [Milk { water, Protein (Casein), Fat }

lactobacillus produce Acid → Partially Digest Milk protein → Milk coagulate

(Growth at suitable temp)

Inoculum → Starter material → Millions of lactobacillus Add in milk in starting

significance — ① Source of Vit B_{12}

② Disease causing Microbes Growth decrease in Gut

Probiotics → Good For health

8.1 Microbes in Household Products

You would be surprised to know that we use microbes or products derived from them everyday. A common example is the production of curd from milk. Micro-organisms such as *Lactobacillus* and others commonly called **lactic acid bacteria (LAB)** grow in milk and convert it to curd. During growth, the LAB produce acids that coagulate and partially digest the milk proteins. A small amount of curd added to the fresh milk as inoculum or starter contain millions of LAB, which at suitable temperatures multiply, thus converting milk to curd, which also improves its nutritional quality by increasing vitamin B_{12}. In our stomach too, the LAB play very beneficial role in checking disease-causing microbes.

other Household products

Fermentation → Produce CO_2 → Food Puffy appearence
many Such products obtain By Fermentation

Baker's yeast → Yeast - Saccharomyces cerevisiae → Produce CO_2 during Fermentation
(Bread & Biscuit making)

Idli and dosa → Bacteria Fermentation produce CO_2
(Puffy appearence)

other Fermented Product → Bamboo stem, Soyabean, Fish
(Fermented & use)

Toddy → South indian drink → obtain From Fermented Sap of 'Palm tree'

The dough, which is used for making foods such as *dosa* and *idli* is also fermented by bacteria. The puffed-up appearance of dough is due to the production of CO_2 gas. *Can you tell which metabolic pathway is taking place resulting in the formation of* CO_2*? Where do you think the bacteria for these fermentations come from?* Similarly the dough, which is used for making bread, is fermented using baker's yeast (*Saccharomyces cerevisiae*). A number of traditional drinks and foods are also made by fermentation by the microbes. 'Toddy', a traditional drink of some parts of southern India is made by fermenting sap from palms. Microbes are also used to ferment fish, soyabean and bamboo-shoots to make foods. Cheese, is one of the oldest food items in which

Cheese

Milk —denature→ water seperate → Salted → Final stage microbe Add (texture, Flavour & taste decide)

- Swiss cheese → large holes
  → By Bacterium → Propiniobacterium sharmanii
- Roquefort Cheese — small holes
  — By Fungi (Penicillium Roquefurti)

Roquefor

Swiss Cheese

shoots to make foods. Cheese, is one of the oldest food items in which microbes were used. Different varieties of cheese are known by their characteristic texture, flavour and taste, the specificity coming from the microbes used. For example, the large holes in 'Swiss cheese' are due to production of a large amount of CO_2 by a bacterium named *Propionibacterium sharmanii*. The 'Roquefort cheese' are ripened by growing a specific fungi on them, which gives them a particular flavour.

Microbes in industry

(a) Beverages → use large size vessels → Fermentors

(b) Antibiotics

③ Other products →

8.2 Microbes in Industrial Products

Even in industry, microbes are used to synthesise a number of products valuable to human beings. Beverages and antibiotics are some examples. Production on an industrial scale, requires growing microbes in very large vessels called **fermentors** (Figure 8.4).

I Alcoholic Beverages

Process → Raw material (malted cereal + Fruits) → Sugar (obtain) —Glycolysis→ Pyruvate —Fermentation→ Ethanol + CO_2

Microbes → Yeast – Saccharomyces cerevisiae (Brewer's yeast) Ethanol Formation – Brewing

Type of Alcoholic Beverage

I Raw material – Malted cereal, potato, Fruit, Sugarcane juit

Type of Alcoholic Beverage Depend on (a) Raw materia
(b) Distilled or Undistilled

- Grapes use → Wine
- Cereal use → Beer

] Undistilled

Brandy
Whisky
Rum

] Distilled

Figure 8.4 Fermentors

8.2.1 Fermented Beverages

Microbes especially yeasts have been used from time immemorial for the production of beverages like wine, beer, whisky, brandy or rum. For this purpose the same yeast *Saccharomyces cerevisiae* used for bread-making and commonly called brewer's yeast, is used for fermenting malted cereals and fruit juices, to produce ethanol. *Do you recollect the metabolic reactions, which result in the production of ethanol by yeast?* Depending on the type of the raw material used for fermentation and the type of processing (with or without distillation) different types of alcoholic drinks are obtained. Wine and beer are produced without distillation whereas whisky, brandy and rum are produced by distillation of the fermented broth. The photograph of a fermentation plant is shown in Figure 8.5.

Antibiotics — Biochemical Reduce Growth or Kill Microbe

meaning — Anti - Greek word - Against life → For Microbes Disease Causing
Bio - life
- For us it is 'Pro life'

First Antibiotics → Alexander Flemming → working on staphylococcus Bacteria

Unwashed plate → → Due to Growth of Fungus (Penicillium) Staphylococcus not Grow

→ Penicillin obtain From Penicillium notatum (Fungi)

Establish role — Ernst chain & Howard Florey — As a Antibiotic Establish Role of Penicillin
(many American soldiers → second world war → Cure)
(Nobel prize)

other Antibiotic → later Discovere From Bacterium (Ex - tetracyclin, Ampicillium)
↳ Plague
Leprosy (Kush rog)
Whooping Cough
Diptheria
— Cured with the help of Antibiotic

Example of Ammensalism
Specien + -
Specien + 0

nentation Plant

8.2.2 Antibiotics

Antibiotics produced by microbes are regarded as one of the most significant discoveries of the twentieth century and have greatly contributed towards the welfare of the human society. *Anti* is a Greek word that means 'against', and *bio* means 'life', together they mean 'against life' (in the context of disease causing organisms); whereas with reference to human beings, they are 'pro life' and not against. Antibiotics are chemical substances, which are produced by some microbes and can kill or retard the growth of other (disease-causing) microbes.

You are familiar with the commonly used antibiotic Penicillin. Do you know that Penicillin was the first antibiotic to be discovered, and it was a chance discovery? Alexander Fleming while working on *Staphylococci* bacteria, once observed a mould growing in one of his unwashed culture plates around which *Staphylococci* could not grow. He found out that it was due to a chemical produced by the mould and he named it Penicillin after the mould *Penicillium notatum*. However, its full potential as an effective antibiotic was established much later by Ernest Chain and Howard Florey. This antibiotic was extensively used to treat American soldiers wounded in World War II. Fleming, Chain and Florey were awarded the Nobel Prize in 1945, for this discovery.

After Penicillin, other antibiotics were also purified from other microbes. *Can you name some other antibiotics and find out their sources?* Antibiotics have greatly improved our capacity to treat deadly diseases such as plague, whooping cough (*kali khansi*), diphtheria (*gal ghotu*) and leprosy (*kusht rog*), which used to kill millions all over the globe. Today, we cannot imagine a world without antibiotics.

Products

Enzymes →

Chemical → Acids

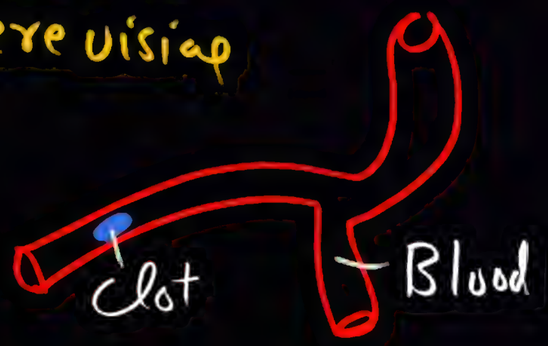
Bioactive molecule →

Chemicals

Acid	Microbe	Type of microbe
① Citric Acid	Aspergillus niger	Fungi
② Butyric Acid	Clostridium Butylicum	Bacterium
③ Acetic Acid	Acetobacter aceti	Bacteria
④ lactic Acid	lactobaccilus	Bacteria

Enzymes

Enzyme	Role	Microbe
I Zymase	→ Production of Ethanol	→ Saccharomyces Cerevisiae
II Lipase	→ Mix with laundry Formulation → Remove oily stains	
III Pectinase Proteases	→ Cleared Bottle Juice By Digesting Fibres	→
IV Streptokinase	→ Act as Clot Buster → Prevent From → Myocardial infraction patient (Prevent heart attach)	→ Streptococcus



8.2.3 Chemicals, Enzymes and other Bioactive Molecules

Microbes are also used for commercial and industrial production of certain chemicals like organic acids, alcohols and enzymes. Examples of acid producers are *Aspergillus niger* (a fungus) of citric acid, *Acetobacter aceti* (a bacterium) of acetic acid, *Clostridium butylicum* (a bacterium) of butyric acid and *Lactobacillus* (a bacterium) of lactic acid.

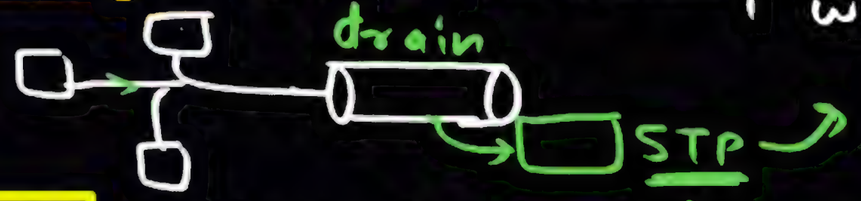
Yeast (*Saccharomyces cerevisiae*) is used for commercial production of ethanol. Microbes are also used for production of enzymes. Lipases are used in detergent formulations and are helpful in removing oily stains from the laundry. You must have noticed that bottled fruit juices bought from the market are clearer as compared to those made at home. This is because the bottled juices are clarified by the use of pectinases and proteases. Streptokinase produced by the bacterium *Streptococcus* and modified by genetic engineering is used as a 'clot buster' for removing clots from the blood vessels of patients who have undergone myocardial infarction leading to heart attack.

Bioactive molecule

name	Microbe	Type	Role
(a) Cylosporin A (Immuno suppressive Agent)	trichoderma Polysporum	Fungi	Immunosuppresive Agent Use in organ transplantation
(b) Statins (Cholesterol lowering Agents)	Monascus purpureus	Yeast (Fungi)	Role → Inhibit competitively to Enzyme involve in Cholesterol synthesis

Sewage treatment plant STP

Sewage – municipal waste | Household waste water → mainly organic waste & Microbe



[Sewage treatment plant → Remove waste From water Befor it Discharge into River)

steps
1. Primary treatment)
2. Secondary treatment)
3. Release into River or tertiary treatment)

Sewage → large debries + Small soil Pebbles + Dissolve organic Water (Kitchen waste Human Excreta + Harmful Microbe

8.3 Microbes in Sewage Treatment

We know that large quantities of waste water are generated everyday in cities and towns. A major component of this waste water is human excreta. This municipal waste-water is also called sewage. It contains large amounts of organic matter and microbes. Many of which are pathogenic. Have you ever wondered where this huge quantity of sewage or urban waste water is disposed off daily? This cannot be discharged into natural water bodies like rivers and streams directly – you can understand why. Before disposal, hence, sewage is treated in sewage treatment plants (STPs) to make it less polluting. Treatment of waste water is done by the

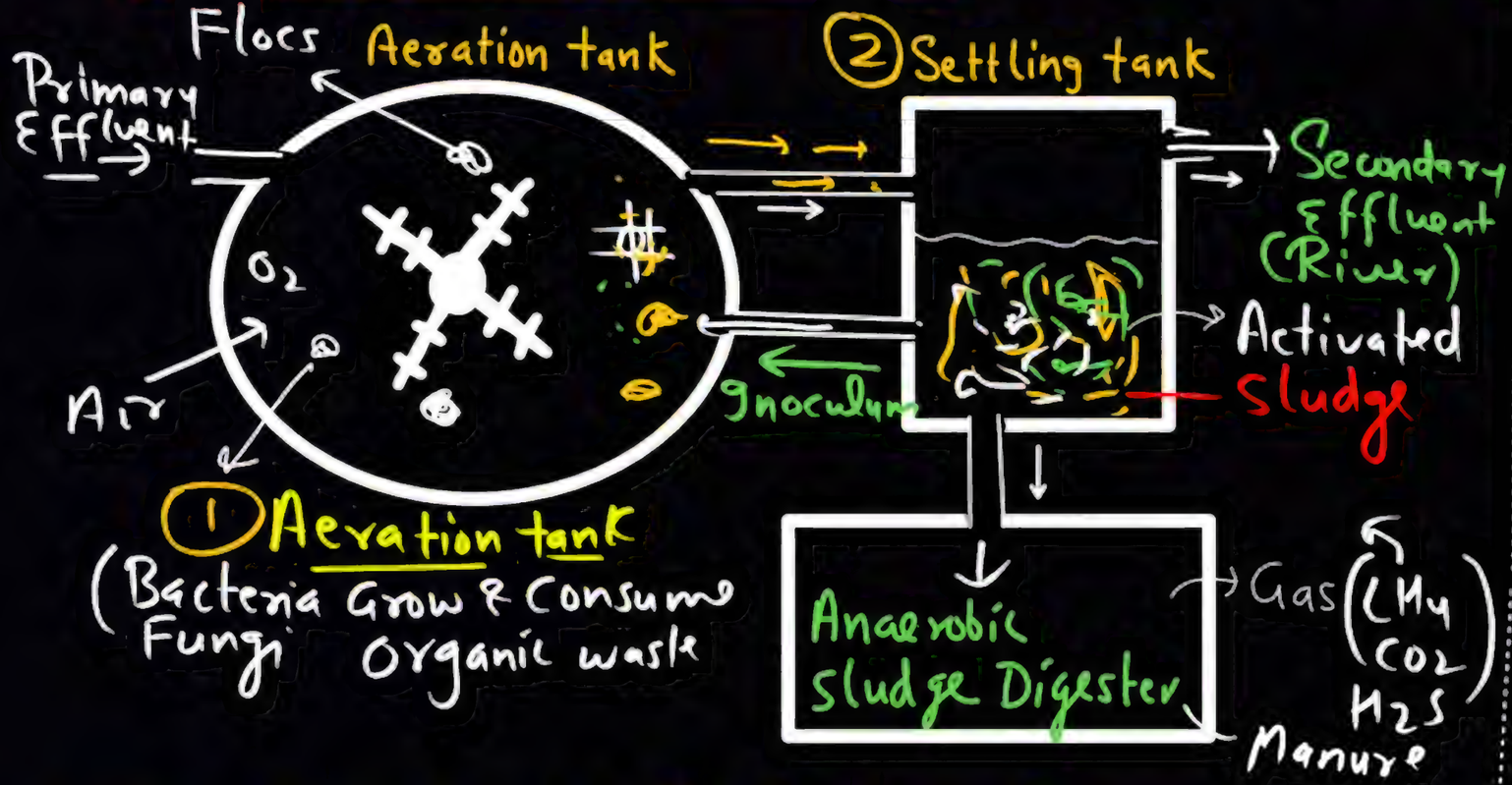
I Primary treatment →

Steps → ① Sequential Filteration (large size debries
② Sedimentation → Soil & Pebbles (Sediment & Form Primary Sludge

Primary Effluent → Produced after primary Enter into Aeration tank

Primary treatment : These treatment steps basically involve physical removal of particles – large and small – from the sewage through filtration and sedimentation. These are removed in stages; initially, floating debris is removed by sequential filtration. Then the grit (soil and small pebbles) are removed by sedimentation. All solids that settle form the **primary sludge**, and the supernatant forms the effluent. The effluent from the primary settling tank is taken for secondary treatment.

Secondary treatment (Other name) - Biological



Flocs → It is mesh like structure of Fungi hyphae & Bacteria

Activated sludge → From settling tank
Small Amount of sludge sent into Aeration (Act as innoculum)

BOD

→ Biochemical oxygen Demand

1 litre water (organic waste → Microbes consume By using O_2

BOD → Amount of Oxygen Require to oxidise/consume complete organic waste in one litre water

More BOD ∝ organic ∝ pollution waste

Aeration tank to settling tank move when → Sufficient Amount decrease for → BOD

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BOD Level (in ppm)	Water Quality
1 - 2	**Very Good** There will not be much organic waste present in the water supply.
3 - 5	**Fair: Moderately Clean**
6 - 9	**Poor: Somewhat Polluted** Usually indicates organic matter is present and bacteria are decomposing this waste.
100 or greater	**Very Poor: Very Polluted** Contains organic waste.

↑ BOD > 100

effluent is passed into large aeration tanks (Figure 8.6) where it is constantly agitated mechanically and air is pumped into it. This allows vigorous growth of useful aerobic microbes into **flocs** (masses of bacteria associated with fungal filaments to form mesh like structures). While growing, these microbes consume the major part of the organic matter in the effluent. This significantly reduces the **BOD (biochemical oxygen demand** of the effluent. BOD refers to the amount of the oxygen that would be consumed if all the organic matter in one liter of water were oxidised by bacteria. The sewage water is treated till the BOD is reduced. The BOD test measures the rate of uptake of oxygen by micro-organisms in a sample of water and thus, indirectly, BOD is a measure of the organic matter present in the water. The greater the BOD of waste water, more is its polluting potential.

Steps in secondary treatment

Aeration tank

- Primary Effluent Agitated with O_2
- Digestion of organic waste (microbes)
- Flocs Form (Fungi + Bacteria

Settling tank

- Once BOD Reduce Effluent From Aeration tank come in Settling tank
- → Floc settle & Form Activated Sludge — Small Amount sent into Aeration tank
- → Produce Secondary Effluent sent into River

Ganga Action Plan
Yamuna

Ministry of Environment

↓

large no of STP to produce to Prevent untreated waste Release into River

Anaerobic sludge Digester

Process - Anaerobic Digestion of Sludge

Gas → CO_2, H_2S + CH_4

- Waste can be Use as manure

You can appreciate how microbes play a major role in treating millions of gallons of waste water everyday across the globe. This methodology has been practiced for more than a century now, in almost all parts of the world. Till date, no man-made technology has been able to rival the microbial treatment of sewage.

Figure 8.7 An aerial view of a sewage plant

You are aware that due to increasing urbanisation, sewage is being produced in much larger quantities than ever before. However the number of sewage treatment plants has not increased enough to treat such large quantities. So the untreated sewage is often discharged directly into rivers leading to their pollution and increase in water-borne diseases.

The Ministry of Environment and Forests has initiated **Ganga Action Plan** and **Yamuna Action Plan** to save these major rivers of our country from pollution. Under these plans, it is proposed to build a large number of sewage treatment plants so that only treated sewage may be discharged in the rivers. A visit to a sewage treatment plant situated in any place near you would be a very interesting and educating experience.

Bio Gas plant

Biogas – End product of Microbial Activity with many Gases
mainly – Methane (use as a fuel)

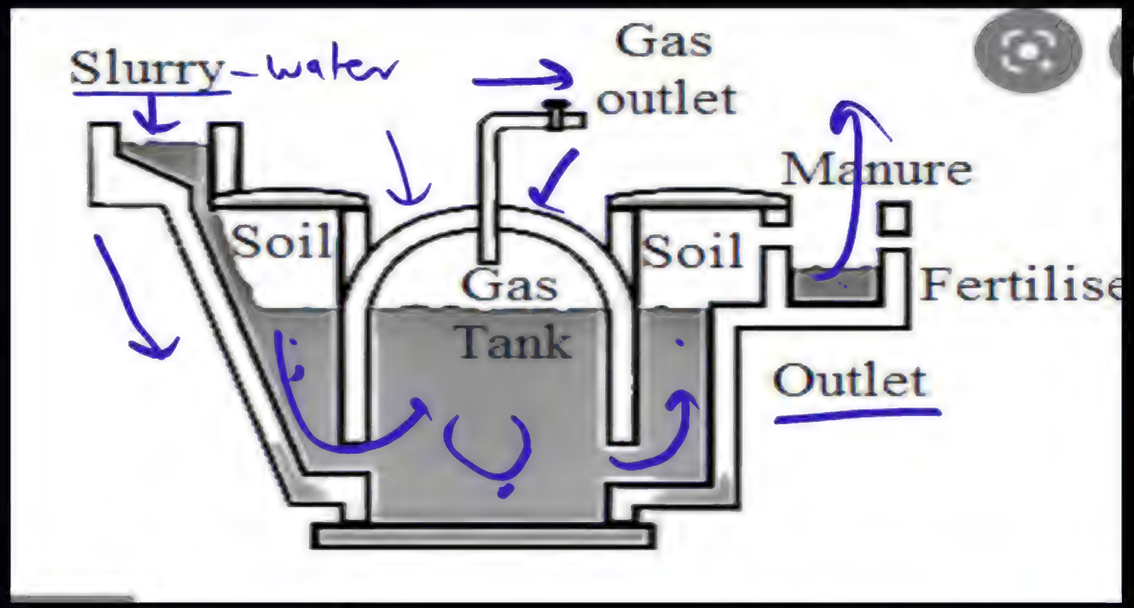
Type of Gas depend on ⟶ (I) Microbe use (II) Raw material

Microbe involve – Ex– Methanogens (Ex– Methanobacterium)
Present in Gut of Ruminant ⟶ help in cellulose Digestion
(large Amount of cellulosic material) Produce methane

Location of Microbe — (a) Gut of Ruminants (CH_4, CO_2, H_2)
↳ Methanogen present in Gobar (Excreta)
(b) Sewage treatment Plant (CH_4, CO_2, H_2S)

Component ⟶ ① 10-15 Feet - tank

② Slurry → Add → Gobar twaker



③ Floating gas holder

④ Undigested waste Remove (Use as a Manure)

Use - ① Fuel
② lighting

KVIC → Khadi village & Industries commision

IARI - Indian Agricultural Research Institute

} together develop technology of Biogas Plant

8.4 Microbes in Production of Biogas

Biogas is a mixture of gases (containing predominantly methane) produced by the microbial activity and which may be used as fuel. You have learnt that microbes produce different types of gaseous end-products during growth and metabolism. The type of the gas produced depends upon the microbes and the organic substrates they utilise. In the examples cited in relation to fermentation of dough, cheese making and production of beverages, the main gas produced was CO_2. However, certain bacteria, which grow anaerobically on cellulosic material, produce large amount of methane along with CO_2 and H_2. These bacteria are collectively called **methanogens**, and one such common bacterium is *Methanobacterium*. These bacteria are commonly found in the anaerobic sludge during sewage treatment. These bacteria are also present in the rumen (a part of stomach) of cattle. A lot of cellulosic material present in the food of cattle is also present in the rumen. In rumen, these bacteria help in the breakdown of cellulose and play an important role in the nutrition of cattle. *Do you think we, human beings, are able to digest the cellulose present in our foods?* Thus, the excreta (dung) of cattle, commonly called *gobar*, is rich in these bacteria. Dung can be used for generation of biogas, commonly called *gobar gas*.

The biogas plant consists of a concrete tank (10–15 feet deep) in which bio-wastes are collected and a slurry of dung is fed. A floating cover is

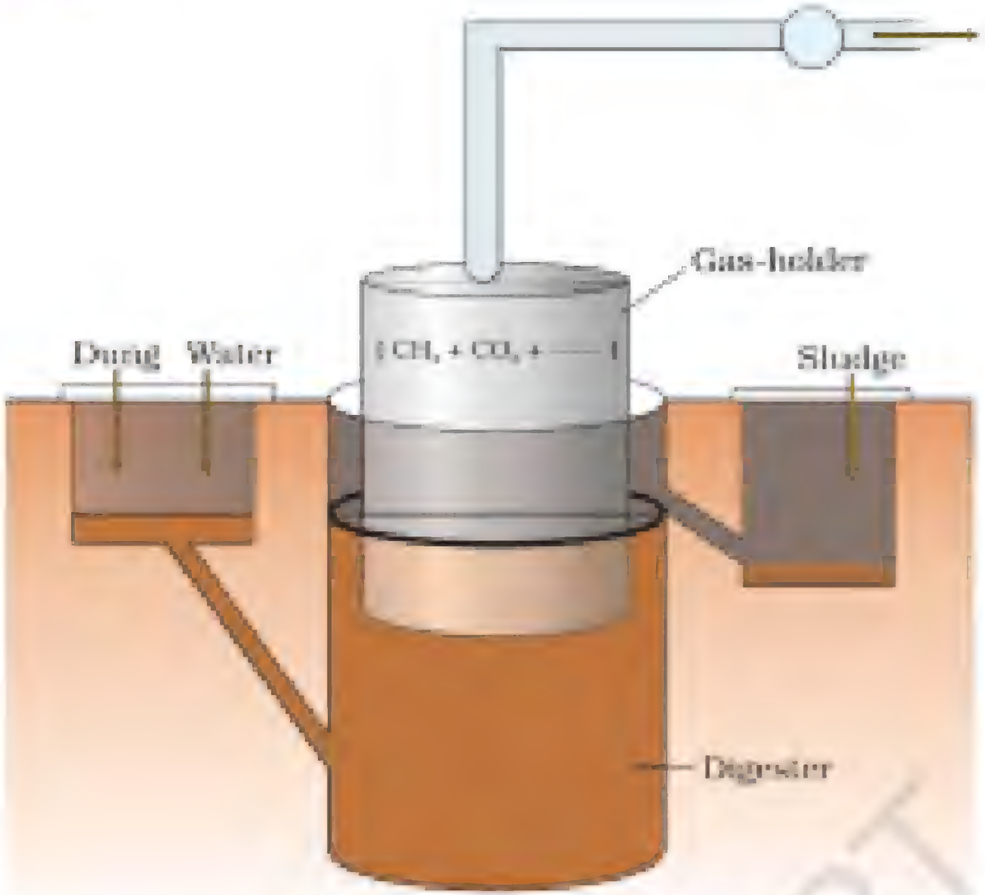


Figure 8.8 A typical biogas plant

placed over the slurry, which keeps on rising as the gas is produced in the tank due to the microbial activity. The biogas plant has an outlet, which is connected to a pipe to supply biogas to nearby houses. The spent slurry is removed through another outlet and may be used as fertiliser. Cattle dung is available in large quantities in rural areas where cattle are used for a variety of purposes. So biogas plants are more often built in rural areas. The biogas thus produced is used for cooking and lighting. The picture of a biogas plant is shown in Figure 8.8. The technology of biogas production was developed in India mainly due to the efforts of Indian Agricultural Research Institute (IARI) and Khadi and Village Industries Commission (KVIC). If your school is situated in a village or near a village, it would be very interesting to enquire if there are any biogas plants nearby. Visit the biogas plant and learn more about it from the people who are actually managing it.

Biocontrol Agents

meaning of Biocontrol → not use of chemical pesticide & insectisides — Cause pollution

↳ Use organism (insect & Fungi) to control population of Insect

Organic Farming
- normal seed (not HYV seeds)
- Biocontrol (not insecticides)
- Biofertilizer (not chemical Fertilizer)

Biomagnification (DDT)

Biocontrol refers to the use of biological methods for controlling plant diseases and pests. In modern society, these problems have been tackled increasingly by the use of chemicals – by use of insecticides and pesticides. These chemicals are toxic and extremely harmful to human beings and animals alike, and have been polluting our environment (soil, ground water), fruits, vegetables and crop plants. Our soil is also polluted through our use of weedicides to remove weeds.

Principle of Biocontrol

→ Based on Natural Predation & Parasitism

→ Organic Farmer → we need not to **kill** or **Eradicate** pest/insect Completely → Population low maintain (chemical insecticide kill Insects completely) (Harmful & Beneficial)

→ **Check** & **balance** involve

→ Biodiversity more – Further **Beneficial**

(Pest → life cycle
Plant – detail
→ natural predator)] detail

develop Biocontrol Agent

our use of weedicides to remove weeds.

Biological control of pests and diseases In agriculture there is a method of controlling pests that relies on natural predation rather than introduced chemicals. A key belief of the organic farmer is that biodiversity furthers health. The more variety a landscape has, the more sustainable it is. The organic farmer, therefore, works to create a system where the insects that are sometimes called pests are not eradicated, but instead are kept at manageable levels by a complex system of checks and balances within a living and vibrant ecosystem. Contrary to the 'conventional' farming practices which often use chemical methods to kill both useful

How to develop Biocontrol Agent

and harmful life forms indiscriminately, this is a holistic approach that seeks to develop an understanding of the webs of interaction between the myriad of organisms that constitute the field fauna and flora. The organic farmer holds the view that the eradication of the creatures that are often described as pests is not only possible, but also undesirable, for without them the beneficial predatory and parasitic insects which depend upon them as food or hosts would not be able to survive. Thus, the use of biocontrol measures will greatly reduce our dependence on toxic chemicals and pesticides. An important part of the biological farming approach is to become familiar with the various life forms that inhabit the field, predators as well as pests, and also their life cycles, patterns of feeding and the habitats that they prefer. This will help develop appropriate means of biocontrol.

name of Biocontrol Agent	Effective Against
① lady Bird	Kill Aphids
② Dragonfly	Kill Mosquito

③ BT - **Baccilus thuriengenesis** → Bacteria → spore stage → Kill 'Caterpillar larvae of Butterflies'

→ spores in Sachet → Mix with water & Spray on Plants (Brassicaceae, Fruit plants) → Spores have toxin → Harmful in gut larvae

→ Currently → toxin gene (cry gene) introduced into plant → BT Plants

④ Trichoderma (Fungi) → In plants act as a Biocontrol Agent

Present as Free living in Root Ecosystem

The very familiar beetle with red and black markings – the Ladybird, and Dragonflies are useful to get rid of aphids and mosquitoes, respectively. An example of microbial biocontrol agents that can be introduced in order to control butterfly caterpillars is the bacteria *Bacillus thuringiensis* (often written as *Bt*). These are available in sachets as dried spores which are mixed with water and sprayed onto vulnerable plants such as brassicas and fruit trees, where these are eaten by the insect larvae. In the gut of the larvae, the toxin is released and the larvae get killed. The bacterial disease will kill the caterpillars, but leave other insects unharmed. Because of the development of methods of genetic engineering in the last decade or so, the scientists have introduced *B. thuringiensis* toxin genes into plants. Such plants are resistant to attack by insect pests. **Bt-cotton** is one such example, which is being cultivated in some states of our country. You will learn more about this in chapter 10.

A biological control being developed for use in the treatment of plant disease is the fungus *Trichoderma*. *Trichoderma* species are free-living fungi that are very common in the root ecosystems. They are effective biocontrol agents of several plant pathogens.

Baculouirus → Belong to Nucleopolyhedro Genus
Kill specific insect not all Arthropoda (target specific)
no harm to – Mammals & Birds, Fish & non target insects
↳ Narrow specturum

IPM – Integrated pest management Programme
↳ Some Ecologically sensitive Area → use → Biocontrol Agen(Narrow Specturum)

Baculoviruses are pathogens that attack insects and other arthropods. The majority of baculoviruses used as biological control agents are in the genus *Nucleopolyhedrovirus*. These viruses are excellent candidates for species-specific, narrow spectrum insecticidal applications. They have been shown to have no negative impacts on plants, mammals, birds, fish or even on non-target insects. This is especially desirable when beneficial insects are being conserved to aid in an overall integrated pest management (IPM) programme, or when an ecologically sensitive area is being treated.

Biofertilizers

- Pollution cause By – Chemical Fertilizers (Soil pollute, Bio magnification, Ground water pollute
- So we need to switch on organic Farming ⟶ No chemical (Bio control, Biofertilizer)

Biofertilizers ⓐ Mycorrhizae
ⓑ N_2 Fixation Bacteria

8.6 Microbes as Biofertilisers

With our present day life styles environmental pollution is a major cause of concern. The use of the chemical fertilisers to meet the ever-increasing demand of agricultural produce has contributed significantly to this pollution. Of course, we have now realised that there are problems associated with the overuse of chemical fertilisers and there is a large pressure to switch to **organic farming** – the use of **biofertilisers**. Biofertilisers are organisms that enrich the nutrient quality of the soil. The main sources of biofertilisers are bacteria, fungi and cyanobacteria.

Mycorrhizae – Fungal Association with Roots of higher (Angio – Orchid, Gymno → Pinus)

- Plant Provide → N_2, Sugar
- Fungi Role – Mineral provide (mainly phosphorus)
  - → Prevent salinity
  - → Drough Resistant
  - → Protect From Root Borne Pathogen

Ex – Genus – Glomus
(Fungi mostly From Mycorrhizae)

Fungi are also known to form symbiotic associations with plants (**mycorrhiza**). Many members of the genus *Glomus* form mycorrhiza. The fungal symbiont in these associations absorbs phosphorus from soil and passes it to the plant. Plants having such associations show other benefits also, such as resistance to root-borne pathogens, tolerance to salinity and drought, and an overall increase in plant growth and development. *Can you tell what advantage the fungus derives from this association?*

Nitrogen Fixation By Microbe

(a) Bacteria → Free living → Azotobacter
↘ Symbiotic → Rhizobium in legumes, Frankia in Alnus } nodules

(b) Cyanobacteria → Nostoc, Anabena, Oscillatoria
↳ two role (i) N_2 Fixation
(ii) Productivity (Photosynthesis → Organic matter Af

Cyanobacteria are autotrophic microbes widely distributed in aquatic and terrestrial environments many of which can fix atmospheric nitrogen, e.g. *Anabaena*, *Nostoc*, *Oscillatoria*, etc. In paddy fields cyanobacteria serve as an important biofertiliser. Blue green algae also add organic matter to the soil and increase its fertility. Currently, in our country, a number of biofertilisers are available commercially in the market and farmers use these regularly in their fields to replenish soil nutrients and to reduce dependence on chemical fertilisers.

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Ecosystem

Botany

TARUN SIR

Ecosystem

Introduction

Productivity

Decomposition

Energy Flow

Ecological Pyramid

- Ecological Sucession
- Biogeochemical cycle

delete

Q1 Population Ecology includes

(a) Migration (b) Adaptation (c) Sex ratio (d) ~~Migration~~ Suspension

Q2 In a Field, 60 mango tree After one Year 15 more plants of mango than Birth rate

$\frac{15}{60} = 0.25$

(a) 2.25 individual/mango/yr ~~(b) 0.250~~ individual/mango/year

(c) 1 individual/mango/yr (d) all

Q3 Faecal pellet and pug marks is measure of

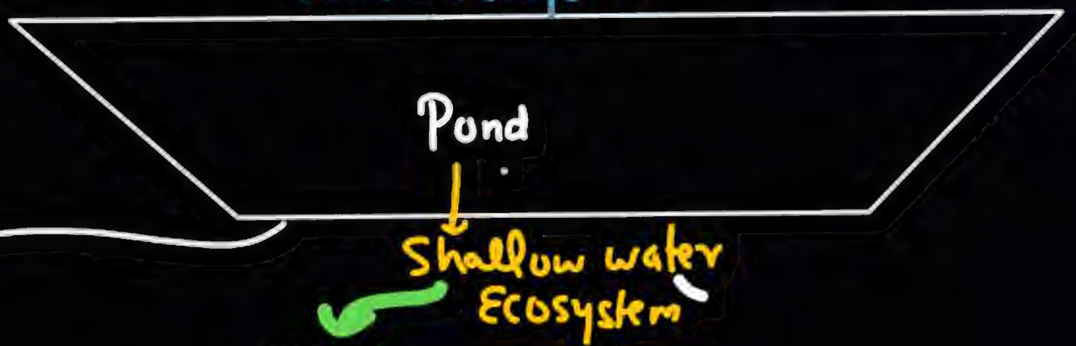
(a) Relative population density ~~(c)~~ Absolute with indirect

(b) Absolute density Direct method (d) all

Example of Ecosystem

Ecology - Study of interaction Biotic & Abiotic

Ecosystem :- Functional unit of nature



Function of Ecosystem

(a) Productivity
(2) Decomposition
(3) Energy Flow (Food Chain)
(4) Nutrient Cycle

Structure

Abiotic

- Light
- water
- Mineral dissolve
- temp
- Soil in Bottom

Biotic

- Producer - Algae / phyto plankton
- Consumer → Zooplankton, Small Fish
- decomposer → Bacteria, Fungi, Flagellates

An ecosystem can be visualised as a functional unit of nature, where living organisms interact among themselves and also with the surrounding physical environment. Ecosystem varies greatly in size from a small pond to a large forest or a sea. Many ecologists regard the entire biosphere as a global ecosystem, as a composite of all local ecosystems on Earth. Since this system is too much big and complex to be studied at one time, it is convenient to divide it into two basic categories, namely the **terrestrial** and the **aquatic**. Forest, grassland and desert are some examples of terrestrial ecosystems; pond, lake, wetland, river and estuary are some examples of aquatic ecosystems. Crop fields and an aquarium may also be considered as man-made ecosystems.

What is Ecosystem – Functional Unit of nature (Self sustaining) (term By – A.G tansley)

Type of Ecosystem

I on the Basis of size
- Small ditch – nano Ecosystem
- Pond → Micro Ecosystem
- River → Macro Ecosystem
- Ocean → Mega Ecosystem

II on the Basis of Habitat – Biosphere → Global Ecosystem (Difficult to study)
So we Divide Ecosystem –
- terrestial → Forest, Desert
- Aquatic → Pond, River, Ocean

III man made and natural – Forest, Desert
↳ Aquarium, Agricultural Field

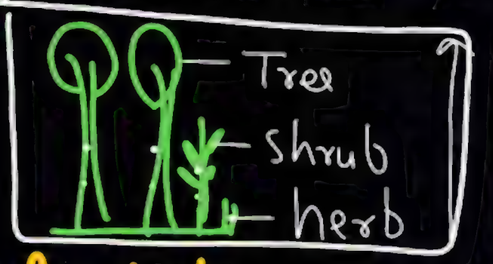
IV complete and incomplete → Most Ecosystem are Complete (all Member Should Present) Producer, Consumer, Decomposer
↳ Deep sea → No producer
Aquarium → Food Add From outside

Feature of Ecosystem

I Structural component – In Any Ecosystem, Structural Component → Biotic, Abiotic

II Functional component → Ecosystem Function By – Productivity, Decomposition
Energy Flow By Food Chain, Mineral Cycling

III Stratification (Pyo) → Vertical Distribution of species
(In Botton – Grass, Middle – Shrub, Top – Tree)



IV standingcrop → Any Given time, Biomass (living) of total plant species in Given time known as Standing Crop

V Standing State → At Any Given time, Amount of Mineral in Soil

Q Decomposition Result in
(a) Inc. Standing Crop
(b) dec in Standing Crop
(c) dec in Standing State
(d) Inc in Standing State

We will first look at the structure of the ecosystem, in order to appreciate the input (productivity), transfer of energy (food chain/web, nutrient cycling) and the output (degradation and energy loss). We will also look at the relationships – cycles, chains, webs – that are created as a result of these energy flows within the system and their inter- relationship.

14.1 Ecosystem – Structure and Function

In chapter 13, you have looked at the various components of the environment- abiotic and biotic. You studied how the individual biotic and abiotic factors affected each other and their surrounding. Let us look at these components in a more integrated manner and see how the flow of energy takes place within these components of the ecosystem.

Interaction of biotic and abiotic components result in a physical structure that is characteristic for each type of ecosystem. Identification and enumeration of plant and animal species of an ecosystem gives its species composition. Vertical distribution of different species occupying different levels is called **stratification**. For example, trees occupy top vertical strata or layer of a forest, shrubs the second and herbs and grasses occupy the bottom layers.

Productivity

Primary Production – Amount of Biomass produce By Plants in Given Area in Given time

Unit – kcal/m^2 (Energy)

g/m^2 (Biomass)

Primary Productivity → Rate of Primary Production (Primary Production For Complete year)

Unit → kcal/m^2/yr

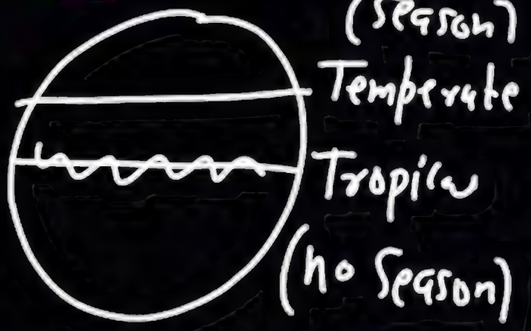
g/m^2/yr

Advantage of Primary Productivity → help in Comparison B/w two Ecosystem

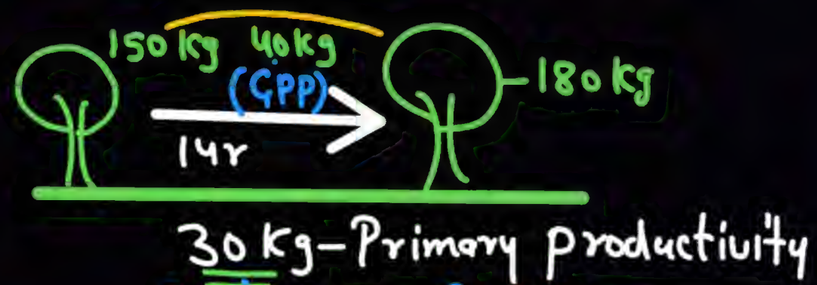
	Tropical Forest	Temperate
Primary production → Jan	10	4
Feb	12	8
March	11	12
	33	24

Primary Productivity → 33 > 24

Note – At Any Given time primary Production is higher in temperate Forest But Primary Productivity is Higher For tropical Forest



Primary Productivity



30 kg – Primary productivity
(Increase) (NPP)

Gross primary productivity (GPP) – total Amount of Food produce

NPP – Actual Increase

Net primary Productivity (NPP) = GPP – R → Respiration loss

→ Consumer like Herbivore ⟶ NPP Available

Some Question

① NPP > GPP → Not possible

② NPP = GPP → Plant not Respire – not possible

③ NPP = 0 (Possible → Rate of Production of Food Equal to Respiration)
(Plant not seems to Be Grow)

④ Leaf Fall → Respiration Rate is more

Factors Which Affect primary Productivity

(I) Environment

(II) Type of Ecosystem

(C) Plants Photosynthetic Efficiency

Secondary productivity

. Increase in Biomass of consumer (Net value)

Goat (40kg) ⟶ Goat (50 kg)

Secondary productivity = 10 kg (Net)

Comparison of productivity

① Land → 30% Earth ⟶ 115 billion tonn
Water → 70% of Earth (170) ⟶ 55 billion tonn

{ land Area is less But productivity is High
Reason → land Light sufficient + Nitrogen in Soil }

② land → Tropical Forest > temperate forest > Grass land > desert tundra

③ Agricultural Field → Highest is Sugar can Field

④ In water → Maximum is coral Reef

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SANKALP NEET VEDANTU

Ecosystem

lecture 02

Botany

TARUN SIR

Ecosystem

Introduction

Productivity

Decomposition

Energy Flow

Ecological Pyramid

- Ecological Sucession
- Biogeochemical cycle

delete

Ecosystem

Definition – Self sustaining System → Biotic interact with Abiotic
(term – A. G tansley)
(Functional Interaction)

Biotic
Abiotic → Produc

Type of Ecosystem

Size — Pond – micro, River – macro, Ocean (Mega

Complete and incomplete → Forest, deep sea

Man Made, natural → Garden, Aquarium, Agricultural Field

Aquatic, terrestial → Ocean, River, Forest, desert

Abiotic

Pond Ecosystem →

Biotic

feature

(a) Structural → Abiotic, Biotic

(b) Functional → Productivity, Energy Flow, Decomposition, Biogeo chemical cycle

(c) Stratification

(d) Standing crop → Given time – Biomass – living

Standing stale – Mineral in soil

Decomposition

definition – Conversion of Organic into Inorganic (CO_2, H_2O, ions)

Detritus → Dead Remain of Plant parts, Animal Excreta other organic

(Detritivore – Earthworm – Break detritus into Pieces)

Steps

dead leaf

① Fragmentation
– Earthworm Break leaf into pieces

② Leaching
After Fragmentation Inorganic mineral (water soluble) goes deep into soil
(Precipitate – as Unavailable Salt

③ Catabolism
On these Fragments Fungi and Bacteria Act
(Extracellular Digestion)

Undisted Organic Convert into Humus

④ Humification – Undigested organic Convert into Humus

Humus
– Black Amorphous
– Microbial Resistant, Slow Decompose
– Slowly Mineral Release

⑤ Mineralization
Slow Decomposition of Humus Release minerals

Important points — • Fragmentation, leaching and Catabolism → occur on detritus
• Humification and Mineralization occur below in soil · in soil

Factors affecting decomposition

(1) Chemical nature of detritus → If detritus is Rich in Nitrogen and Sugar – Fast decomposition
↳ Lignin & chitin → Decomposition Slow

(2) Temperature → 25 - 30°C → Fast decomposition
low temp → Enzyme not very Active (Organic Matter) Buildup

(3) Oxygen → Aerobic condition — Fast decomposition
Anaerobic → Slow Decomposition

(4) Humidity or Moisture → Moisture help For Germination of spore of Fungi & Bacteria

I Fragmentation
II Catabolism
III Mineralization
(IV) leaching

How many occur on detritus

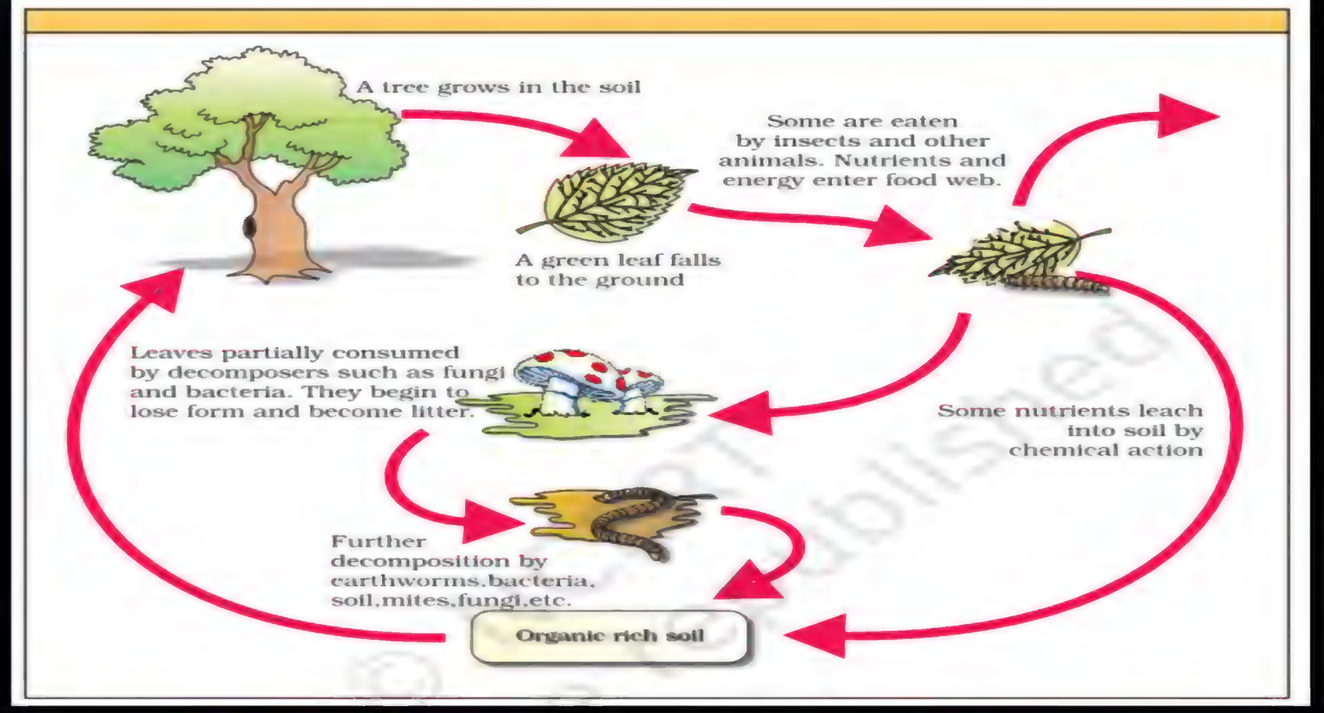
(a) I, II, IV
(b) I, II, III, IV
(c) I & II

14.3 Decomposition

You may have heard of the earthworm being referred to as the farmer's 'friend'. This is so because they help in the breakdown of complex organic matter as well as in loosening of the soil. Similarly, decomposers break down complex organic matter into inorganic substances like carbon dioxide, water and nutrients and the process is called **decomposition**. Dead plant remains such as leaves, bark, flowers and dead remains of animals, including fecal matter, constitute **detritus**, which is the raw material for decomposition. The important steps in the process of decomposition are fragmentation, leaching, catabolism, humification and mineralisation.

Detritivores (e.g., earthworm) break down detritus into smaller particles. This process is called **fragmentation.** By the process of **leaching,** water-soluble inorganic nutrients go down into the soil horizon and get precipitated as unavailable salts. Bacterial and fungal enzymes degrade detritus into simpler inorganic substances. This process is called as **catabolism**.

It is important to note that all the above steps in decomposition operate simultaneously on the detritus (Figure 14.1). Humification and mineralisation occur during decomposition in the soil. **Humification** leads


A tree grows in the soil
A green leaf falls to the ground
Some are eaten by insects and other animals. Nutrients and energy enter food web.
Leaves partially consumed by decomposers such as fungi and bacteria. They begin to lose form and become litter.
Some nutrients leach into soil by chemical action
Further decomposition by earthworms,bacteria, soil,mites,fungi,etc.
Organic rich soil

to accumulation of a dark coloured amorphous substance called **humus** that is highly resistant to microbial action and undergoes decomposition at an extremely slow rate. Being colloidal in nature it serves as a reservoir of nutrients. The humus is further degraded by some microbes and release of inorganic nutrients occur by the process known as **mineralisation**.

Decomposition is largely an oxygen-requiring process. The rate of decomposition is controlled by chemical composition of detritus and climatic factors. In a particular climatic condition, decomposition rate is slower if detritus is rich in lignin and chitin, and quicker, if detritus is rich in nitrogen and water-soluble substances like sugars. Temperature and soil moisture are the most important climatic factors that regulate decomposition through their effects on the activities of soil microbes. Warm and moist environment favour decomposition whereas low temperature and anaerobiosis inhibit decomposition resulting in build up of organic materials.

Energy Flow

Except deep sea Hydrothermal vent → In all Ecosystem Source of Energy is Sunlight

X-ray — U.V

PAR (400 – 700 nm) → Photosynthetically Active Radiation → 50% of total Sunlight is PAR

Plant use → 2 to 10% of PAR | 1-5% of total Sunlight

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law of thermodyanimics

- First law → From one trophic level to another Energy Flow Some Energy lost By Respiration — only unidirectional Flow of Energy

Sun —(10,000 kJ)→ Plant (100 kJ) —I→ Herbivore —I→ Carnivore
(R at Plant, R at Herbivore)

Second law → Entropy is Increasing (organism need to take Food to overcome Randomness)

Trophic Level → It is not Physical presence
→ It is nutritional Role of Any organism in Food Chain

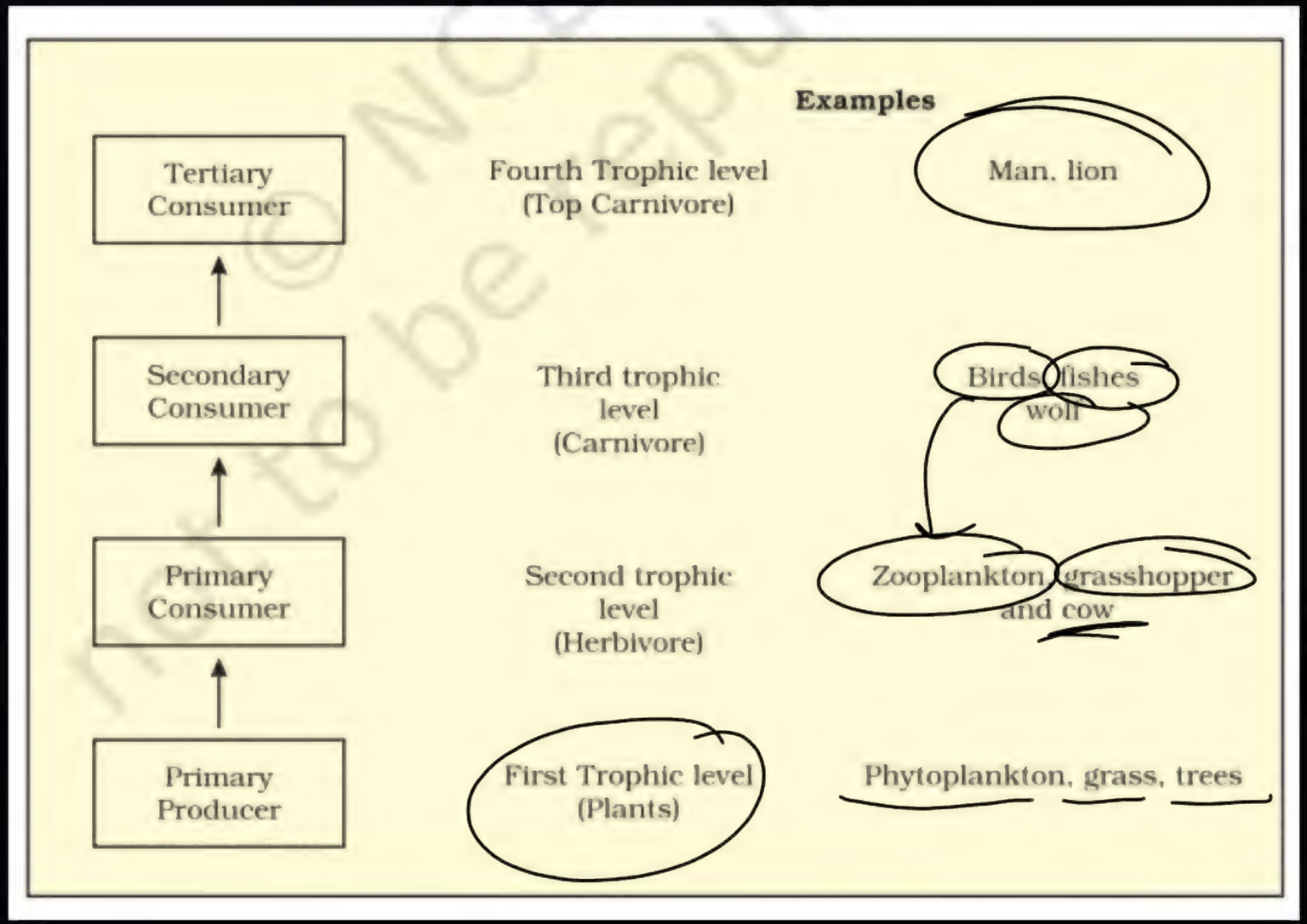
I Grass ⟶ II Grass hopper ⟶ Bird ⟶ Lion

Trophic level				
	(lower trophic level)			
I	Primary producer	Autotrophs	land - tree, Grass Water - Phytoplankton Algae	
II	Secondary Producer	Primary Consumer	Herbivore →	land - Grass hopper - Seed Eating Bird Water → Zooplankton
III	Tertiary producer	Secondary Consumer	Carnivore →	land → Bird, Snake Wolf Mollusca, Fishes
(IV)	Top consumer (Higher trophic level)	Secondary Carnivore (tertiary consumer)	→	lion large Fish

Q Tertiary producer is not

(a) Carnivore (b) Secondary Consumer

(c) 3rd trophic level ~~(d)~~ Herbivore


Examples
Tertiary Consumer
Fourth Trophic level (Top Carnivore)
Man, lion
Secondary Consumer
Third trophic level (Carnivore)
Birds, fishes
wolf
Primary Consumer
Second trophic level (Herbivore)
Zooplankton, grasshopper and cow
Primary Producer
First Trophic level (Plants)
Phytoplankton, grass, trees

14.4 Energy Flow

Except for the deep sea hydro-thermal ecosystem, sun is the only source of energy for all ecosystems on Earth. Of the incident solar radiation less than 50 per cent of it is **photosynthetically active radiation** (PAR). We know that plants and photosynthetic bacteria (autotrophs), fix suns' radiant energy to make food from simple inorganic materials. Plants capture only 2-10 per cent of the PAR and this small amount of energy sustains the entire living world. So, it is very important to know how the solar energy captured by plants flows through different organisms of an ecosystem. All organisms are dependent for their food on producers, either directly or indirectly. So you find unidirectional flow of energy from the sun to producers and then to consumers. *Is this in keeping with the first law of thermodynamics?*

Food chain and Food web

Food chain – Interlinked trophic level is Food chain
Interdependency of Difference species For Food

Food web ⟶ Interlinked Food chain (Connections should be natural)

Feature of Food chain — ① Move than Four trophic level Food chain is Rare
(Reason – Energy loss in Each trophic level → Very less Energy Remain For last trophic level

② Primary producer (1-5% Sunligh Absorb) But next trophic level Maximum 10% Pass on ⟶ 10% law

Grass	→	G·H	→	Bird
100 ICJ		10 ICJ		1 ICJ

③ Food chain start with primary producer → Grazing Food chain (GFC (2nd level Herbivore)
↳ Start with dead organism ⟶ DFC (Detritus Food chain (2nd Level Decomposers) Saprotroph (nutrition)

Type of Food chain

GFC → Grazing Food chain, 1st trophic level Primary producer (Grass, tree, Phytoplankton)
→ It occur on land and water also

DFC → Detritus Food chain (1st trophic level – dead Material)
– It Also occur on land and water

note → On land More is DFC (Detritus Food chain)
land have high productivity → Most of Food as Plant goes into soil For Decomposition

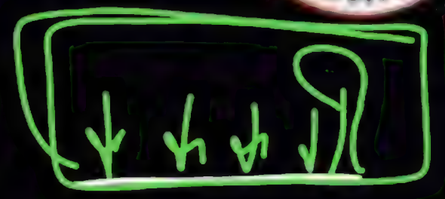
note → At some point DFC can link to GFC

Grass → G.H → Bird → Lion (GFC)
Dead → Earthworm → Bird ↗
(DFC)

Eltonian pyramid

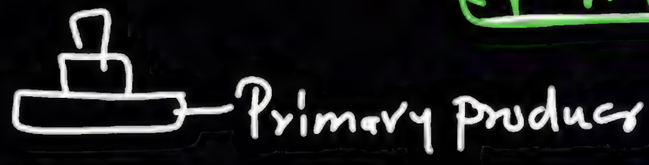
Ecological pyramid

Definition – It is Graphical Representation B/w Different trophic level in terms of Number, biomass and Energy



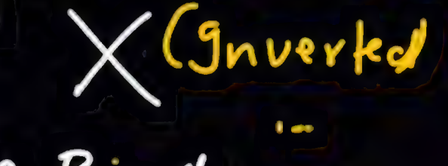
Somebasics to Draw pyramid

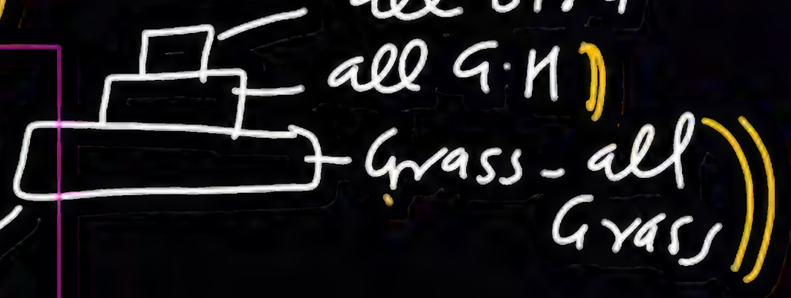
(1) Base of pyramid → Always primary producer Draw



(2) All member of trophic level of should be Counted

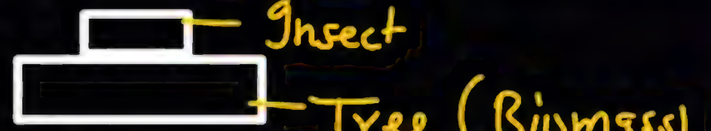
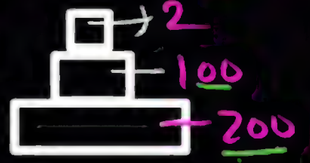
(3) It is Drawn For GFC





GFC
- Grassland → Grass → Grass hopper → Bird
- Forest → Tree → Insect
- Aquatic → Phytoplankton → Zooplankton → Small Fish

Example of Ecological Pyramid

	Energy	Number	Biomass
Grassland	Upright		
Forest			
Aquatic			(Inverted

note - Energy Always upright, (Aquatic – Biomass) (Forest – Number inverted)

Draw Back of Ecological Pyramid – ① Ecological pyramid is For Food chain But nature have Food web

② Saprotroph is important (Ecological pyramid is not For DFC

③ Crow - Omnivorus → Present more than one trophil level + Double Counting

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SANKALP NEET VEDANTU

Biodiversity and conservation

lecture-01

Botany

TARUN SIR

Biodiversity and Conservation

- Biodiversity ✓
- Levels of Biodiversity ✓
- How much Biodiversity present ✓
- Pattern of Biodiversity ✓
- significance of Biodiversity ✓
- Biodiversity Loss
- Reason For loss ✓
- conservational Biodiversity

Basic Introduction → Alien visit on Earth

So much Biodiversity on Earth →

- Beetle → 3 lakh
- Fish → 28K
- orchids → 20K
- Ants → 20K

- Why so much species ✓
- Such Diversity Exist throughout Earth History ✓
- How Diversity Form ✓
- → Importance of Biodiversity ✓

Q Maximum Biodiversity
(a) Beetle (b) Fish
(c) Gymnosperm (d) Ants

If an alien from a distant galaxy were to visit our planet Earth, the first thing that would amaze and baffle him would most probably be the enormous diversity of life that he would encounter. Even for humans, the rich variety of living organisms with which they share this planet never ceases to astonish and fascinate us. The common man would find it hard to believe that there are more than 20,000 species of ants, 3,00,000 species of beetles, 28,000 species of fishes and nearly 20,000 species of orchids. Ecologists and evolutionary biologists have been trying to understand the significance of such diversity by asking important questions (1) *Why are there so many species?* (2) *Did such great diversity exist throughout earth's history?* (3) *How did this diversification come about? How and why is this diversity important to the biosphere? Would it* (4) *function any differently if the diversity was much less? How do humans benefit from the diversity of life?*

what is Biodiversity → Diversity at all level of Biological organization
(From macromolecule to cell, tissue, organism & species, Ecosystem)

term popularised By Edward wilson (Sociobiologist)

levels of Bio diversity

① Genetic level ⟶ Members of same species (Difference at Genetic level)

Rauwolfia vomitoria (Himalaya Region) ⟶ Reserpine (Chemical) ⟶ Use to cure B.P

This plant show variation with Distribution (Range)

(a) Amount of Reserpine
(b) Potency of that chemical

② Species level ⟶ Different type of species

Western ghat have more species than Eastern ghat (Amphibian)

③ Ecological Diversity ⟶ Different type of Ecosystem → India – Desert, Coastal Area

Coral reef, Alpine Forest, Mangroves

Scandivian country (Norway & Denmark ⟶ less Ecological Diversity

Q Maximum Biodiversity

(a) two breed of cow

(b) two Strain of Bacteria

(c) Mongloid & Negroid

~~(d)~~ Rice and Mango

(Genetic level

Same species

Different species

combined diversity at all the levels of biological organisation.
The most important of them are–

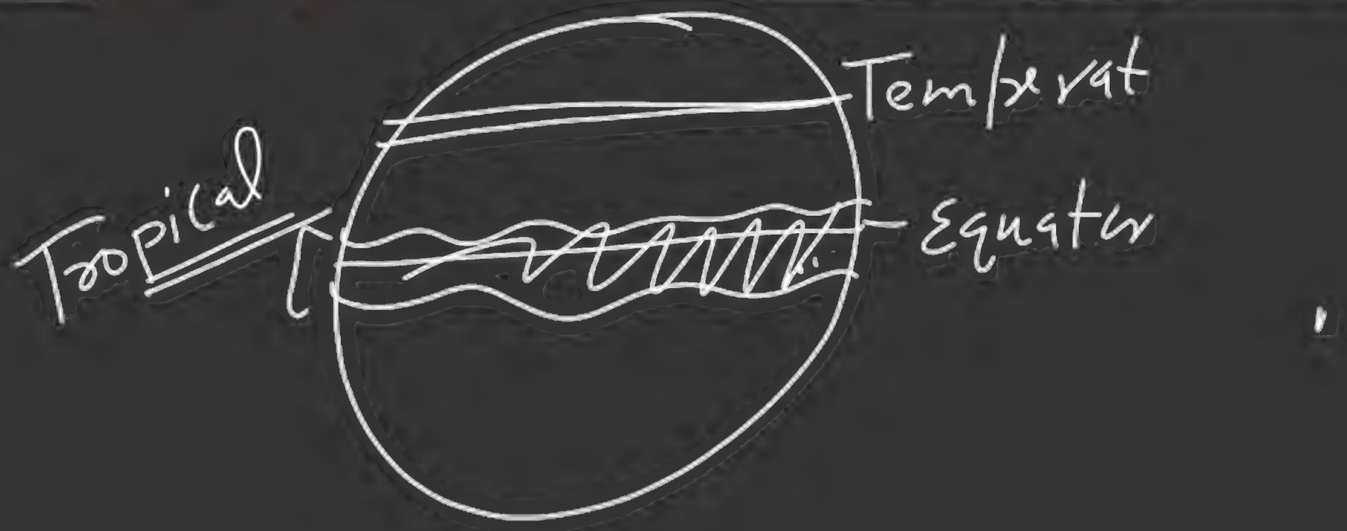
(i) ***Genetic diversity***: A single species might show high diversity at the genetic level over its distributional range. The genetic variation shown by the medicinal plant *Rauwolfia vomitoria* growing in different Himalayan ranges might be in terms of the potency and concentration of the active chemical (reserpine) that the plant produces. India has more than 50,000 genetically different strains of rice, and 1,000 varieties of mango.

(ii) ***Species diversity***: The diversity at the species level. For example, the Western Ghats have a greater amphibian species diversity than the Eastern Ghats.

(iii) ***Ecological diversity***: At the ecosystem level, India, for instance, with its deserts, rain forests, mangroves, coral reefs, wetlands, estuaries, and alpine meadows has a greater ecosystem diversity than a Scandinavian country like Norway.

It has taken millions of years of evolution, to accumulate this rich diversity in nature, but we could lose all that wealth in less than two centuries if the present rates of species losses continue. Biodiversity and its conservation are now vital environmental issues of international concern as more and more people around the world begin to realise the critical importance of biodiversity for our survival and well- being on this planet.

Robert may



How many species on Earth – Above 1·5 million (IUCN – International Union For Conservation of nature) 2004

– Actual number/total number – Predicted By Robert may (7 million)

Some point consider → Tropical Area undiscovered species more compare to temperate

– Insect Group – large no. of species Undiscovered

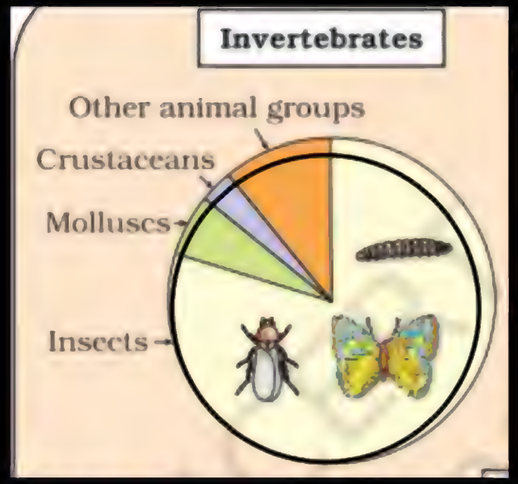
Since there are published records of all the species discovered and named, we know how many species in all have been recorded so far, but it is not easy to answer the question of how many species there are on earth. According to the IUCN (2004), the total number of plant and animal species described so far is slightly more than 1.5 million, but we have no clear idea of how many species are yet to be discovered and described. Estimates vary widely and many of them are only educated guesses. For many taxonomic groups, species inventories are more complete in temperate than in tropical countries. Considering that an overwhelmingly large proportion of the species waiting to be discovered are in the tropics, biologists make a statistical comparison of the temperate-tropical species richness of an exhaustively studied group of insects and extrapolate this ratio to other groups of animals and plants to come up with a gross estimate of the total number of species on earth. Some extreme estimates range from 20 to 50 million, but a more conservative and scientifically sound estimate made by Robert May places the global species diversity at about 7 million.

How much Biodiversity on Earth

① 100% [Animals → 70%. Plants – 22% (Fungi include) others – 8%.

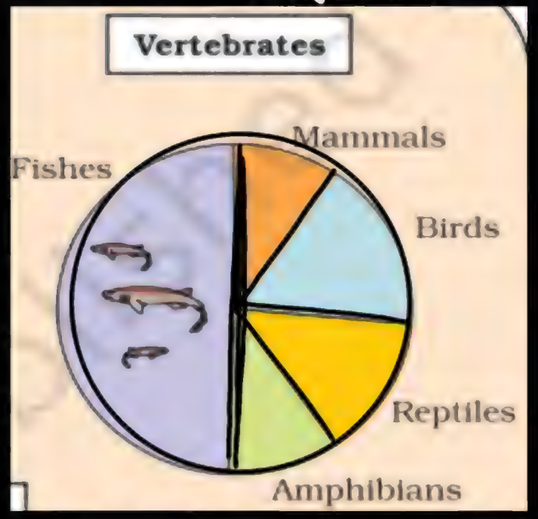
② Among Animals mostly insects

③ out of Every ten Animal – 7 are Insect

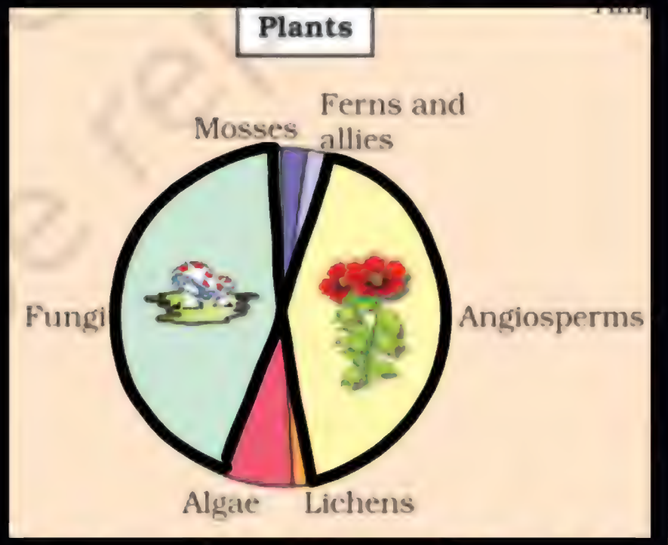


Insects > other Animal > Mollusca > Crustaceans

Vertebrate



Fish > Birds > Amphibians
Reptiles Mammals



Angiosperm > Fungi > Algal > Ferns > lichens
Moss

Q Most Biodiversity
(a) Mollusca (b) Crustaceans
(c) Arthropoda (d) Insecta

Q Maximum Biodiversity
(a) Pteropsida (b) Lycopsida (c) Bryopsida (d) Sphenopsida

– Fungi species > combine Fish, Reptiles (Vertebrates)

Bacteria is not included in counting of species Diversity

(a) Current taxonomic method, not Appropriate For Bacteria

(Many Bacteria can not be culture in lab
(Feature study Difficult)

[Collection of species & than Feature Study → new species Discovered)

(b) Modern method Bases on Biochemical & Genetic detail → of this the Basis For Classification → Problem is Bacteria Species can go into millions

Let us look at some interesting aspects about earth's biodiversity based on the currently available species inventories. More than 70 per cent of all the species recorded are animals, while plants (including algae, fungi, bryophytes, gymnosperms and angiosperms) comprise no more than 22 per cent of the total. Among animals, insects are the most species-rich taxonomic group, making up more than 70 per cent of the total. That means, out of every 10 animals on this planet, 7 are insects. Again, how do we explain this enormous diversification of insects? The number of fungi species in the world is more than the combined total of the species of fishes, amphibians, reptiles and mammals. In Figure 15.1, biodiversity is depicted showing species number of major taxa.

It should be noted that these estimates do not give any figures for prokaryotes. Biologists are not sure about how many prokaryotic species there might be. The problem is that conventional taxonomic methods are not suitable for identifying microbial species and many species are simply not culturable under laboratory conditions. If we accept biochemical or molecular criteria for delineating species for this group, then their diversity alone might run into millions.

Biodiversity in India

India land Area (2.4% of total land Area)

India Biodiversity 8.1% → India is Biodiversity Rich country (12 Mega biodiversity Country)

Animals (1 lakh) Plants (45,000) } — Discovered

Robert may Estimate → till now only 22% Discovered

If Robert may Estimate correct → Above 1 lakh Plant, Above 3 lakh Animals } need to be discovered

Can we Able to find How much Biodiversity present → not possible

(a) Skilled person & limitited Manpower

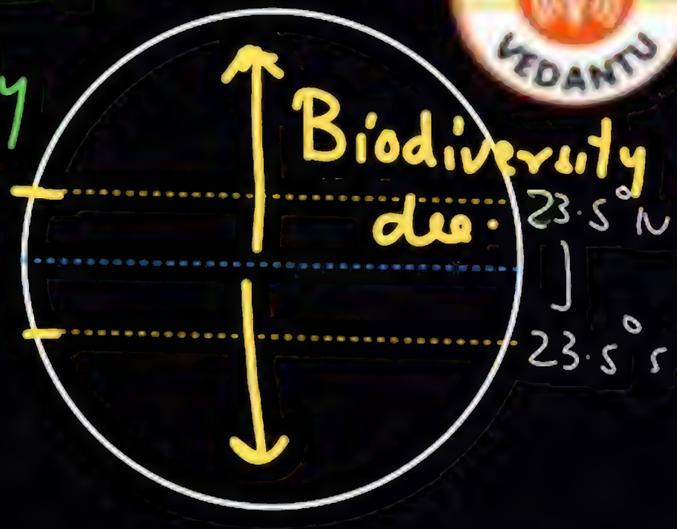
(b) Rate of Biodiversity loss is high (less)

Although India has only 2.4 per cent of the world's land area, its share of the global species diversity is an impressive 8.1 per cent. That is what makes our country one of the 12 mega diversity countries of the world. Nearly 45,000 species of plants and twice as many of animals have been recorded from India. How many living species are actually there waiting to be discovered and named? If we accept May's global estimates, only 22 per cent of the total species have been recorded so far. Applying this proportion to India's diversity figures, we estimate that there are probably more than 1,00,000 plant species and more than 3,00, 000 animal species yet to be discovered and described. Would we ever be able to complete the inventory of the biological wealth of our country? Consider the immense trained manpower (taxonomists) and the time required to complete the job. The situation appears more hopeless when we realise that a large fraction of these species faces the threat of becoming extinct even before we discover them. Nature's biological library is burning even before we catalogued the titles of all the books stocked there.

Pattern in Biodiversity

① Biodiversity Change with lattitute
② Biodiversity Change with Area

I. Lattitudinal Gradient – As we move Away From Equator, Biodiversity decrease



Some Data to support this

① Maximum no. of species → 23.5° N to 23.5° S ☆

② Bird species → Colombia – 1400, India – 1200
New york – 105, Amazon Forest – 1300
Green land – 56

③ Equador → 10 time more vascular plant compare to USA

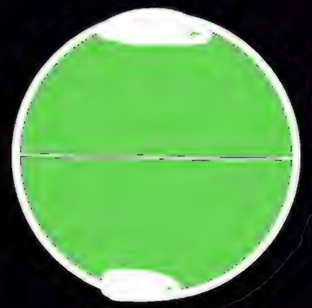
Amazon Forest → 1.25 lakh – Insects, 3000 Fish, 378 – Reptiles
40000 Plants, 1300 Birds, 425 – Mammals, Amphibian

Q lowest Bird species
(1) Newyork (b) India (c) Greenland (d) Colombia

Why Equator show Most Biodiversity

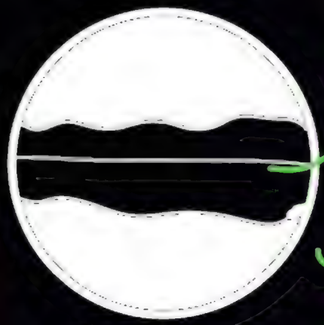
(a) Tropical Areas → least Disturbed Glaciation → New species Formation – Suffitient time Available

(New species Formation is Function of time)

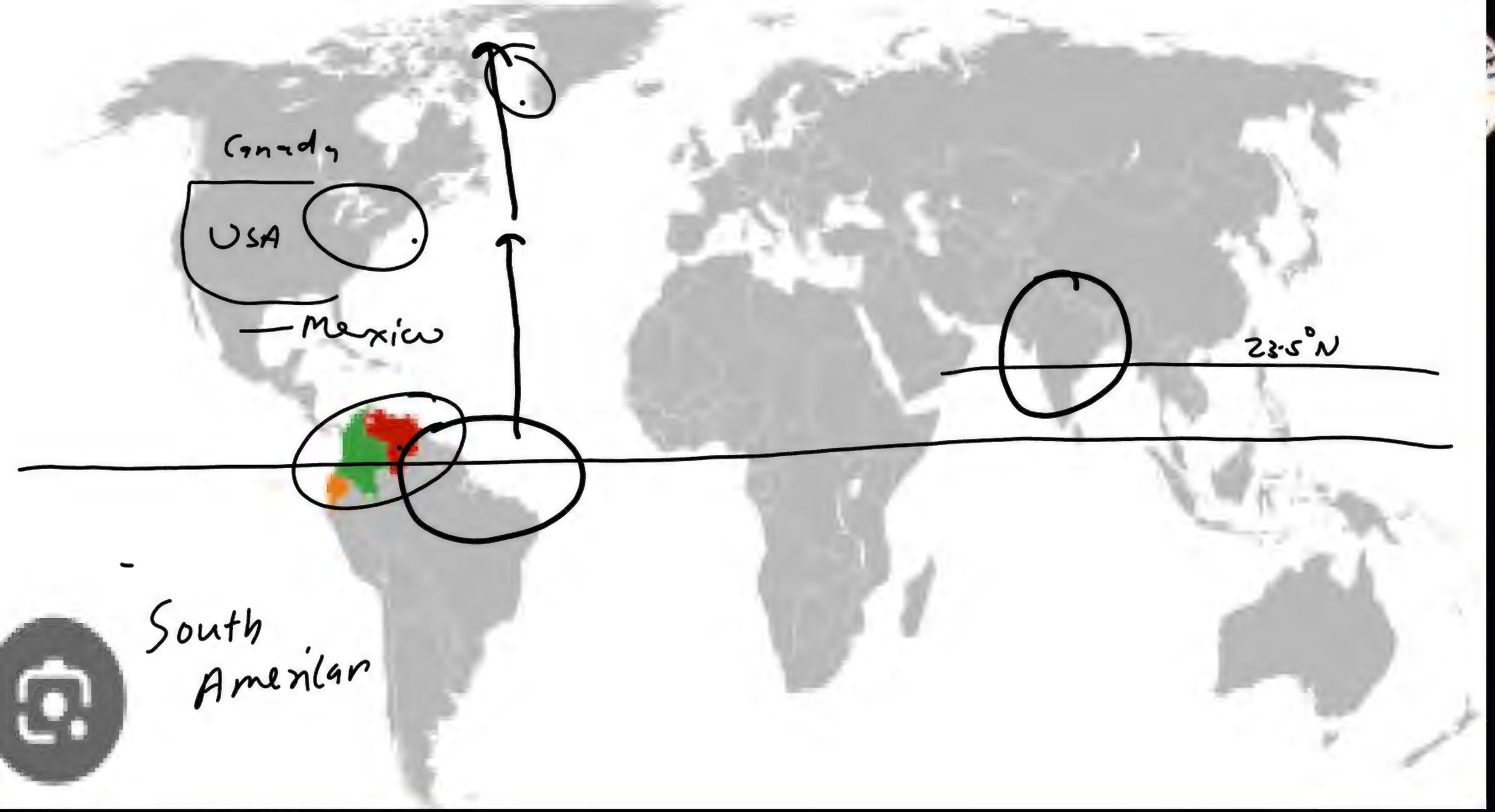


(b) Tropical Area Season Absent → less variation

Complete year → same Climate — Niche specilization promote new species Form



(c) Equator have More Sunlight – More productivity → indirectly contribute in speciation.


Canada
USA
Mexico
23.5°N
South
Amerilar

15.1.2 Patterns of Biodiversity

(i) ***Latitudinal gradients***: The diversity of plants and animals is not uniform throughout the world but shows a rather uneven distribution. For many group of animals or plants, there are interesting patterns in diversity, the most well- known being the latitudinal gradient in diversity. In general, species diversity decreases as we move away from the equator towards the poles. With very few exceptions, tropics (latitudinal range of 23.5° N to 23.5° S) harbour more species than temperate or polar areas. Colombia located near the equator has nearly 1,400 species of birds while New York at 41° N has 105 species and Greenland at 71° N only 56 species. India, with much of its land area in the tropical latitudes, has more than 1,200 species of birds. A forest in a tropical region like Equador has up to 10 times as many species of vascular plants as a forest of equal area in a temperate region like the Midwest of the USA. The largely tropical Amazonian rain forest in South America has the greatest biodiversity on earth- it is home to more than 40,000 species of plants, 3,000 of fishes, 1,300 of birds, 427 of mammals, 427 of amphibians, 378 of reptiles and of more than 1,25,000 invertebrates. Scientists estimate that in these rain forests there might be at least two million insect species waiting to be discovered and named.

What is so special about tropics that might account for their greater biological diversity? Ecologists and evolutionary biologists have proposed various hypotheses; some important ones are (a) Speciation is generally a function of time, unlike temperate regions subjected to frequent glaciations in the past, tropical latitudes have remained relatively undisturbed for millions of years and thus, had a long evolutionary time for species diversification, (b) Tropical environments, unlike temperate ones, are less seasonal, relatively more constant and predictable. Such constant environments promote niche specialisation and lead to a greater species diversity and (c) There is more solar energy available in the tropics, which contributes to higher productivity; this in turn might contribute indirectly to greater diversity.

Species area Relationship

Scientist – Alaxander Von Humboldt (German naturalist)
Work – South American Forest

– Increase Area of consideration, species Richess increase (Upto limit)

Equation → S = Species Richness
A = Area
Z = Regression constant

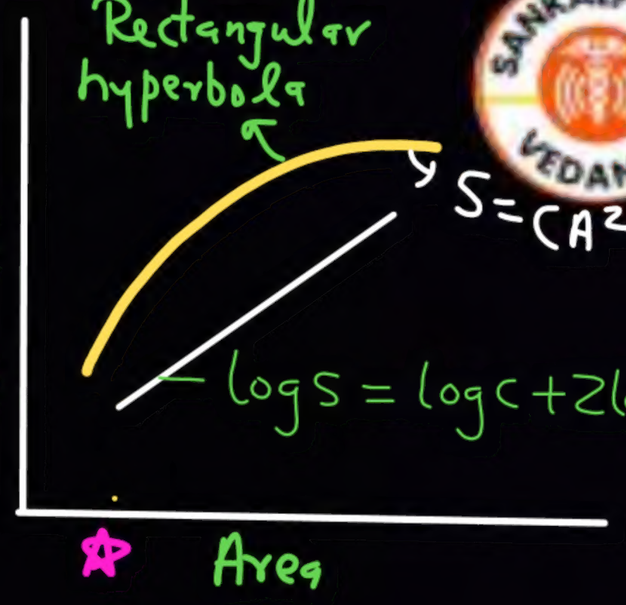
$$S \propto A^Z$$

$$S = CA^Z$$

$$\log S = \log C + Z \log A$$

(y = c + m x)

Z = Slope



value of – Z → ① It is B/w 0·1 to 0·2 (irrespective of Area & taxonomic Group)

② Some Group – Mammals, Birds] – value → 0·6 to 1·2
large Area (continent)
high – steep slope

③ Mammals → 1·16

(ii) ***Species-Area relationships*** : During his pioneering and extensive explorations in the wilderness of South American jungles, the great German naturalist and geographer Alexander von Humboldt observed that within a region species richness increased with increasing explored area, but only up to a limit. In fact, the relation between species richness and area for a wide variety of taxa (angiosperm plants, birds, bats, freshwater fishes) turns out to be a rectangular hyperbola (Figure 15.2). On a logarithmic scale, the relationship is a straight line described by the equation

$$\log S = \log C + Z \log A$$

where

S = Species richness A = Area

Z = slope of the line (regression coefficient)

C = Y-intercept

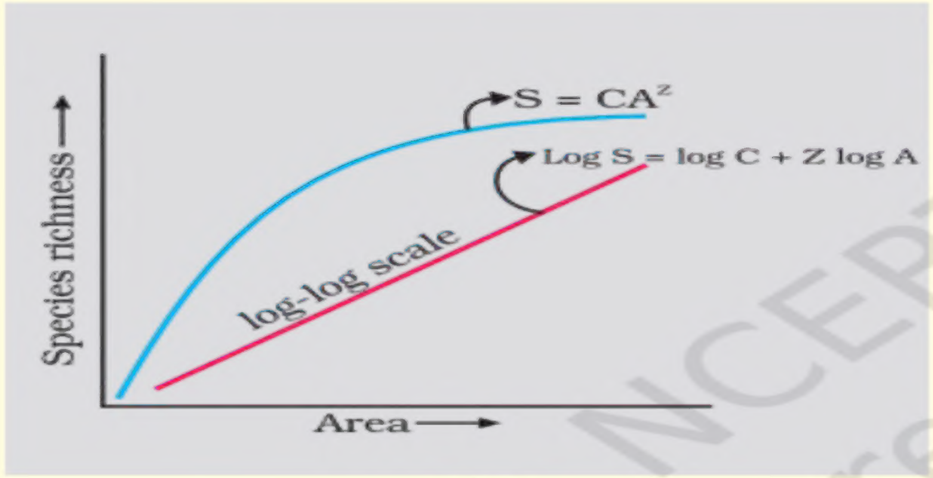


Figure 15.2 Showing species area relationship. Note that on log scale the relationship becomes linear

Ecologists have discovered that the value of Z lies in the range of 0.1 to 0.2, regardless of the taxonomic group or the region (whether it is the plants in Britain, birds in California or molluscs in New York state, the slopes of the regression line are amazingly similar). But, if you analyse the species-area relationships among very large areas like the entire continents, you will find that the slope of the line to be much steeper (Z values in the range of 0.6 to 1.2). For example, for frugivorous (fruit-eating) birds and mammals in the tropical forests of different continents, the slope is found to be 1.15. *What do steeper slopes mean in this context?*

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